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Alternative Methods of Financing Wastewater Treatment

Environmental Protection Agency

October 1975

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EPA-230/3-76-002

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PB 251 305

ECONOMIC REPORT
ALTERNATIVE METHODS OF FINANCING WASTEWATER TREATMENT

REPORT
of the
ADMINISTRATOR OF THE ENVIRONMENTAL
PROTECTION AGENCY
to the
CONGRESS OF THE UNITED STATES
In Compliance With
Section 317 of Public Law 92-500

THE FEDERAL WATER POLLUTION CONTROL ACT,
AS AMENDED

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

October 1975

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA-230/3-76-002

2.

3. Recipient's Accession No.

4. Title and Subtitle
Alternative Methods of Financing Wastewater Treatment

5. Report Date
October 1975

6.

7. Author(s) W. Smith, D. Hale, M. Rose, J. Goldstein

8. Performing Organization Rept. No. EPA-230/3-76-002

9. Performing Organization Name and Address
Environmental Protection Agency
Office of Planning & Evaluation/Office of Research & Development
401 M St., S.W., Washington, D.C. 20460

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Same

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes
Report to Congress

16. Abstracts

This Report was prepared in response to Section 317 of the Federal Water Pollution Control Act Amendments of 1972, in which the Administrator of EPA was directed to continue to investigate and study the feasibility of alternative methods of financing the costs of water pollution abatement.

In an effort to be responsive to current Congressional interests, the basic options that were studied were: (1) improvements to the existing Contruction Grants Program, (2) an Environmental Trust Fund, and (3) an Environmental Loan Program. The analysis does not address the management of the Construction Grants Program. The Report is concerned with economic/financial alternatives.

17. Key Words and Document Analysis. 17a. Descriptors

Environmental Economics, Financing Alternatives, Water Pollution Economics, Contruction Grants Program, Trust Funds

17b. Identifiers/Open-Ended Terms

PRICES SUBJECT TO CHANGE

17c. COSATI Field/Group

18. Availability Statement
Unlimited

19. Security Class (This Report)
UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages
136

22. Price
6.00-2.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

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ALTERNATIVE METHODS OF FINANCING WASTEWATER TREATMENT

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ACKNOWLEDGMENTS

This Report to Congress was prepared under the direction of Mr. Willard W. Smith, of the Office of Planning and Evaluation, Environmental Protection Agency. The nucleus of the team that performed the analysis consisted of Mr. Smith, Dr. Marshall Rose and Dr. Jon Goldstein, Office of Research and Development, and Dr. Douglas Hale, of the Office of Planning and Evaluation. Able support was provided by Mr. John Foran and Mr. Eric Scheuer of the Resource Planning Associates, Inc. Others who assisted in this Report were Ms. Maria Mykolenko and Dr. Richard Schaefer of the Offices of Planning and Evaluation and Research and Development, respectively. While at EPA, Dr. David H. Davis aided in the formative stages of the Report.

ALTERNATIVE METHODS OF FINANCING WASTEWATER TREATMENT

ERRATA SHEET

Page II-2, 1st Paragraph, 2nd Sentence, should read:

> Although Federal aid was made available to the States for pollution studies and to assist in planning pollution control programs in 1948 (P.L. 80-845), the practice of making direct grants to State and local governments for the contruction of pollution control facilities did not begin until Public Law 660 in 1956.

Page II-2, 2nd Paragraph, 3rd Sentence, should read:

> The Environmental Protection Agency took over administration of the program in December 1970.

(Changes to original text are underlined)

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EXECUTIVE SUMMARY

This report to the Congress is in response to Section 317 of the Federal Water Pollution Control Act Amendments of 1972, in which Congress directed the Administrator of the Environmental Protection Agency to:

> ...continue to investigate and study the feasibility of alternative methods of financing the cost of preventing, controlling, and abating pollution ... including, but not limited to, the feasibility of establishing a pollution abatement trust fund. The results of such investigation and study shall be reported to the Congress... together with recommendations of the Administrator for financing the programs...for the fiscal years beginning after fiscal year 1976, including any necessary legislation.

The overall objective of the 1972 Amendments was to restore and maintain the integrity of the nation's waters. To accomplish this goal, the determination of financing needs, the potential for improvement within the present system, and practical financial alternatives that might be used to meet the needs are important areas for analysis.

Furthermore, the exploration of financial incentives should be studied in the context of aiding in preventing and abating both point and non-point sources of pollution. In generic terms, the sources of pollution that are candidates for analysis include industrial wastes, municipal waste, waste from agricultural activities, runoff from construction sites, acid mine drainage, and accidental spills/deliberate dumping of polluting materials. In terms of emphasis, most of the Environmental Protection Agency's efforts and resources have been aimed at point-source control. For example, the Contruction Grant Program accounts for more than 85 percent of the Agency's annual budget authority. This relative emphasis is also reflected in this Report.

Though the number of detailed financing arrangements is almost unbounded -- given the possibility of combinations and gradations of financial mechanisms -- the generic alternatives are limited to a few. Furthermore, in light of the previous financing Report to Congress,[1] which was a broad and comprehensive survey of financing alternatives, analyses of the current grants program and a few practical alternatives to the program appeared to be the most responsive and worthwhile focus for this Report. In this context, the basic options that were studied were threefold:

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[1] Alternative Financing Methods for Clean Water, Environmental Protection Agency, Office of Water Programs, September 1971.

1. Improvements to the existing grants program itself,
2. An Environmental Trust Fund, and
3. A Federal Environmental Loan Program.

The analysis does not address the management or administration of the Construction Grants Program. The Report is concerned with economic/ financial alternatives. Before discussing improvements to the current grants program, a brief synopsis of the trust fund and loan options will be presented.

Environmental Trust Fund

The argument for an environmental trust fund is that environmental controls, and specifically water pollution control, will be a continuing necessity for our society that might deserve a sustained source of revenues. The trust fund would provide a measure of continuity and independence to the conduct of water quality control activities.

The arguments against such a fund are the arguments made against trust funds in general. For the most part, trust funds are criticized because of their inflexibility, nonresponsiveness, administrative costs, and tendency to encourage questionable projects. The inflexibility comes about whenever funds are placed in trust or in earmarked categories to be used only for specified purposes irrespective of need, i.e., despite competing priorities for alternative uses of the funds in question. Nonresponsiveness occurs because the fund size is not necessarily related to the requirements of the fund's purposes or to changes in national priorities over time. Administrative costs of trust fund arrangements, although not necessarily exorbitant, reduce the amount of money available for fund purposes. The availability of funds in the trust-account set aside for specific types of programs often encourages implementation of projects of marginal or questionable value.

A trust fund is mainly an accounting technique to protect funds for a program, and there is no evidence that it will achieve improvement in the economic characteristics of the Construction Grant Program. Moreover, the certainty with a trust fund of ready (virtually automatic) availability of monies no longer exists. P.L. 93-344, the Congressional Budget and Impoundment Control Act of 1974, requires annual Congressional review and approval before funds can be used. On balance, there do not appear to be compelling reasons to recommend a trust fund for use in conjunction with the current program.

Environmental Loan Program

A Federal environmental loan program, in order to provide a realistic option to the existing grant program, would have to be set up at a "below-market" interest rate low enough that the loan subsidy and grant subsidy are at least roughly equivalent. Further, it is sometimes suggested that a loan program would guarantee eventual program self-sufficiency. It could be designed to encourage both more efficient initial facility design and improved operation and maintenance in subsequent years. On the other hand, a loan program would not result in a reduced Federal financial role unless the program interest rate were high enough so that the total interest subsidy would be less than the immediate subsidy provided by a grant. Thus, if a loan program were designed to reduce the Federal financial role, it would also provide a reduced incentive for construction of wastewater treatment facilities. Examples of the (subsidized) interest rates required to achieve financial equivalence with Federal grant rates are presented in Chapter V.

The option of exchanging the current grant program for a reduced-interest loan program is not especially realistic for initiation at this time. There has been little indication of legislative interest in such a drastic programmatic switch in order to achieve benefits that can be obtained in alternative ways. The administrative difficulties that would occur with a shift from grants to loans would be substantial enough that the ultimate objective, obtaining clean water, might be delayed. The administrative problems appear to be threefold.

First, if a loan program were initiated, there could be significant procedural uncertainty in the EPA regions, in the States and in the municipalities as the process shifted from grants to loans. The result of this uncertainty would be a lag in transition between the grant and loan programs. States and municipalities would await the new procedures and guidelines before proceeding with their plans. The EPA would have to adjust its staffing and organization to meet the new requirements, and servicing loan payments would require development over time of a sizable bureaucracy.

Second, until the current backlog of projects is depleted, it would be difficult to shift to a new financing program. Maintaining two programs to review and fund projects would be confusing and costly.

Third, the legislation in PL 92-500 would have to be drastically changed to permit a shift from grants to loans. As with any new financing program, among the problems to be resolved would be the basis for distributing funds and the degree to which existing pre-grant requirements should be incorporated within the loan program. The resolution of such questions for a new program is generally more difficult and time consuming than the introduction of improvements to an already existing program.

Hence, for the practical reasons suggested above, a loan program is not recommended at this time. Perhaps when the current backlog of major projects has been completed, such a program would be more viable. At this time, a shift in the technique of financing the program would tend to delay pollution abatement and complicate the administration of the program.

Improvements to the Grant Program

Analyses are presented in this Report in the areas of allotments; technological, project, and cost eligibilities; grant rate; design period; and industrial cost recovery. The various pros and cons of alternative courses of action are discussed.

Allotments

The existing basis for alloting monies based on "Needs", or States' estimates of the costs to comply with PL 92-500, can be improved to better serve both economic efficiency and equity. In addition, as has occurred in the past, the Needs formula basis for allotments should omit ineligible or speculative items (such as stormwater control). Also, since the largest share of funds is allotted to those States with the largest estimates of costs (Needs) to be incurred, there is an incentive for an upward bias to the cost estimates. Though the lack of time-phasing (discounting) in the Needs estimates leads to future Needs being weighted (and funded) equally with current Needs, the existing limitation on authorizations causes this to be unimportant in the short run. Several conceptual bases for allotments are explored in Chapter IV. These need additional empirical analysis before being pursued further. In the interim, the addition of a population variable to the allotment process may improve the economic characteristics of the distribution of funds.

Eligible Technologies and Projects

The reliance on end-of-pipe technology at the expense of other alternatives to control point and nonpoint sources is, in principle, inefficient. In practice, however, the actual efficiency loss, if it occurs at all, appears to be very slight. As discussed in Chapter IV, this is because (1) due to its limited applicability, in-stream technology may supplement, but does not substitute for, end-of-pipe treatment; (2) the economic efficiency and implementation determinations of nonpoint sources technology and management control strategies are still in the research stage; and (3) to achieve an economically efficient solution, implementation of in-stream and nonpoint source technologies in conjunction with appropriate end-of-pipe treatment requires regional management authorities with unprecedented decision-making (and perhaps taxing) authority. Given the reluctance of communities to relinquish part of their control to regional authorities, the lack of progress toward comprehensive water quality management is not surprising, i.e., conflicting community growth, industrialization, taxing, and water quality preferences tend to preclude formation of the basin planning, control, and financing institutions requisite for the economic utilization of the alternative technologies. These factors narrow the range of technology and management options.

In the absence of comprehensive and powerful regional planning authorities, suggestions for maintaining a broad Federal project eligibility structure encounter difficulties similar to those mentioned in the paragraph above. However, a further problem is that Federal funding of storm sewers, collector sewers, and (often) of interceptor projects must be carefully weighed because of the reduction in funds available for projects that are generally more cost-effective and that would not be constructed in the absence of Federal support. These latter projects include waste treatment works, correction of infiltration and inflow, combined sewer overflows,[1] and (sometimes) interceptors.

In analyzing the question of eligibilities, one must consider not only the cost-effectiveness of individual project categories, but also the local response to Federal funding and the constraints on total Federal monies available. That is, given the limitation on authorizations, Federal funds should concentrate on funding those projects that, in the absence of the Federal program, would not be supported by local governments. The project category eligibilities should be viewed in a hierarchical fashion, with treatment plants and correction of infiltration/inflow at the top. However, cases do arise where projects in other categories are very cost-effective. A practical solution to highlight the differences in project effectiveness in achieving clean water may be to vary the grant rate by project category.

Cost Eligibilities and Grant Rate

The high (75%) grant rate, coupled with the limitation of the subsidy to capital costs, is generally held by critics of the Program to lead both to a capital bias and to underperformance of facilities. A lowering of the grant rate and/or one of a number of O&M type subsidies are generally proposed to alleviate the problem.

The arguments against lowering the grant rate rest on several grounds. A lower rate is held to discourage communities from building facilities, either because they could not afford or would not choose to undertake such projects. The result would tend to be delay in achieving water quality goals (through litigation, if necessary). In addition, to the extent that the grant rate was set at 75% to prevent an undue cost burden from falling on communities, its reduction may be inequitable (particularly with respect to poorer communities).

It is sometimes suggested that an O&M subsidy could improve facility performance, make up for the loss in capital grant subsidy (so that the same level of total project costs would be funded) and reduce the capital bias. In principle, this is correct. However, a problem associated with O&M subsidies (if based on cost criteria) is that there is a great deal of difficulty in accurately estimating future O&M costs for individual projects. Approximations over groups of plants can be made, but they are imprecise on a case-by-case basis. If reimbursement for O&M expenditures were to be based on actual, experienced (rather than estimated future) costs, there would be no assurance of efficient performance (and every incentive to overspend for O&M). Even if the subsidy were to be based on performance criteria, one must demonstrate that monies spent to subsidize O&M are more cost-effective than the same funds would be if used to construct additional capital facilities. Moreover, O&M subsidies tend to move in the direction of a large, indefinite commitment of Federal funds. It would appear more reasonable to continue to "internalize" O&M costs by incorporating them in user charges. Also, due to PL 92-500, a mechanism to encourage better performance is already in existence (the NPDES). Since a commitment to provide adequate facility performance is required in municipal permits, before costly alternatives are implemented, the "Permit Program" should be given a chance to perform its monitoring function.

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[1] Due to the localized nature of the combined sewer problem (80% of Needs for combined sewer overflows are concentrated in 10 States), consideration might be given to treating the eligibility (e.g., through a separate authorization) and/or grant rate (e.g., a slightly lower grant rate could be considered) differently from those for other facilities.

Design Period

The issue of excessive capacity is sometimes raised with respect to the construction of waste treatment facilities. EPA specifies the planning period within which individual communities may determine the appropriate design period, i.e., the expected interval between expansions of pollution abatement projects.

Before P.L. 92-500, the tendency with regard to reserve capacity was to follow "rules of thumb" -- a 20-year design period for treatment plants and a 50-year period for interceptors. EPA analysis has subsequently shown that, given the relatively low interest rates prevailing at the time, the 20/50 policy was not unreasonable. The Act emphasized "cost-effective" design periods, and in the time period since 1972 this has become a requirement. In fact, EPA analysis (see Appendix C) now indicates that, given current conditions, 20/50 design periods usually exceed the optimum. The range for cost-effective design periods vary considerably, however, from about 5-20 years for treatment plants to about 20-40 years for interceptors. Because of this variability, stipulation of specific design period limitations applicable to all facilities nationwide would be arbitrary.

Industrial Cost Recovery

The municipality's retention of one-half of the treatment facility investment recovered from industry, as well as the lack of an interest charge recovered from industry on this investment, effectively increase the Federal contribution to abatement and provide an indirect subsidy to industrial users of public treatment. 1/

1/ The existence of "red tape" and uncertainties regarding pretreatment requirements may, in practice, offset some portion of this subsidy.

These provisions encourage construction of capital-intensive and excessively large facilities to treat industrial wastes, are inequitable inasmuch as industrialized communities receive, in effect, a larger cost share than more residential communities, and provide incentives for industry to connect to a municipal system when private treatment (in the absence of the provisions) might otherwise be cheaper. Under certain conditions, it can be shown that not having to repay any interest on the industrial grant share is equivalent to about a 70% subsidy to industrial users. However, before one suggests this subsidy be eliminated, account should be taken of the tax savings that are available in private treatment, e.g., accelerated depreciation, the investment tax credit, Industrial Revenue Bonds (IRB's). If one recognizes that some firms can finance at least part of their own treatment systems through IRB's, and if one allows for the effects of faster depreciation rates and interest schedules, the magnitude of the resulting subsidy in public treatment is eliminated. In fact, for firms that can get IRB's, there may be a financial bias in favor of private treatment.

If the (indirect) subsidies available to industry in public treatment were eliminated, there might not be sufficient incentive for firms to tie into municipal systems. The existence of the private subsidies mentioned above would cause a substantial bias away from public treatment. In order to prevent this bias, the use of the private subsidies would have to be prohibited. However, the private subsidies are outside the sphere of direct EPA influence. Though it may be advantageous in terms of economic efficiency for society to dispense with both types of subsidies, if the subsidies in private treatment are to continue, it appears worthwhile to retain the public subsidies as well.

II. SCOPE OF REPORT

Given the objective of cleaning up the nation's waterways in an efficient and equitable fashion, the role of Federal public finance is to examine the sources and uses of funds to explore: What is funded, who pays, and the economic consequences (effects) of the funding. A good deal of the conceptual discussion addressing these points for wastewater treatment is already contained in the previous (1971) Financing Report to Congress and will not be repeated here. Sections B. and D. of this Chapter do, however, discuss criteria for evaluating economic effects and (as background discussion) present the pros and cons of the alternative implementation mechanisms (i.e., regulations, subsidies, effluent charges) for achieving water cleanup objectives.

Several factors outside the financing area have served to constrain the choice of financing alternatives to be examined in this Report. For example, there has been little indication of Congressional interest in diverging widely from the concept of a grants program. Hence, only alternatives consistent with the current program or with some transition from the grants program have been considered. Furthermore, it appears reasonable to assume the Federal role will continue at approximately the existing level of authorizations, at least until the current backlog is funded. At the same time, the alternatives that are explored are consistent with reducing the Federal role and with eventual attainment of self-sufficiency by municipalities. No attempt to evaluate the management or administration of the Construction Grant Program has been made. This Report is concerned with economic/financial alternatives.

An important constraint to efficient economic actions relates to the issue of public versus private ownership of resources. Though application of economic theory can speak to the efficiency and equity consequences of (say) industrial subsidies, past Congressional actions in this area would appear to indicate support for the notion that industry is, to some extent, a victim of the necessity to impose pollution controls and thus should be subsidized through such measures as rapid amortization and industrial revenue bonds. If this is an accurate assessment of both past and current Congressional sentiment, the choice and particular provisions of financing alternatives are again limited. Where appropriate, this Report takes note of the consequences of this attitude.

The result of these limitations or constraints is to narrow the consideration of financing alternatives to a practical few. These are:

o Improvements to the current program,

o A federal environmental loans program, and

o An environmental trust fund.

Historical Perspective

The history of Federal financial assistance for wastewater treatment has been one of increasing Federal participation. Although Federal aid was made available to the states for pollution studies and to assist in planning pollution control programs in 1948, the practice of making direct grants to State and local governments for the construction of pollution control facilities did not begin until 1956 (P.L. 80-845). Authorization of $500 million, to cover construction for the Fiscal Years 1957-66, was made. In 1961 (P.L. 87-88), 1965 (P.L. 89-234), and 1966 (P.L. 89-753), because of public awareness of the need for improved water pollution control, authorizations continued to be increased.

By 1966, the maximum Federal share of construction cost had risen to 55 percent. Authorizations for the period 1968-71 were to rise steadily each year, from $450 million (for 1968) to $1.25 billion (for 1971). The Environmental Protection Agency took over administration of the program in July 1970.

The most thorough revision of the Construction Grants Program occurred in 1972 with the enactment of P.L. 92-500. The Act established requirements for universal secondary treatment by 1977 and fishable/swimmable water quality standards for 1983, conditions for grant eligibility were extensively modified, the Federal share was increased to a maximum of 75 percent of project construction costs, and the authorized level of Federal funding was greatly increased (to $ 5 billion, $6 billion, and $7 billion for FY's 1973, 1974, and 1975, respectively). Furthermore, the Act granted contract authority in these amounts, permitting the Agency to award grants prior to actual appropriation.

The rationale for such widespread changes stemmed from general recognition that earlier Federal/state programs were inadequate to accomplish water cleanup goals. The scant data available indicated that at best the nation had only "held the line" on common organic pollution in recent decades. The effects of increased treatment had been virtually cancelled by larger wasteloads. Congressional sentiment was that the nation as a whole ought to work toward an ultimate clean water goal. With respect to municipalities, an expanded Federal grant program was believed needed to construct sewage treatment plants.

Implicit in the series of enactments mentioned above is the notion that State/local action to finance wastewater treatment would be somewhat limited in the absence of Federal participation. That is, without financial incentives, many State and local governmental units could not afford or would not choose to construct sufficient wastewater facilities to meet the national goals for clean water. In either case, Federal incentives have been provided to induce cleanup of the nation's waterways in a more timely manner. In addition, the Federal government has an overview responsibility to achieve national objectives in an efficient and equitable fashion. Actions (or lack thereof) envisioned from a local point of view may not be consistent with national goals. It is incumbent on the Federal government to step in to promote the national welfare in cases where State and local efforts alone might not achieve this objective.

A. REPORT ORGANIZATION

Chapter II is designed to lay a framework for the subsequent discussions. The overall scope of the Report has been presented. The remainder of this Chapter discusses the evaluation criteria for the analysis, studies used in support of the Report, and the alternative implementation mechanisms (regulations, subsidies, effluent charges) for promoting pollution abatement.

Chapter III is a brief description of the basic features of the Construction Grant Program, as mandated in the Act.

Chapter IV briefly reviews economic shortcomings resulting from the legislation and then discusses improvements that could be made to the current grants program.

Chapter V analyzes the institution of a loan-oriented program and the setting up of an environmental trust fund. A trust fund is, of course, consistent with any other financial options that might be considered.

Certain detailed discussions and analyses of specific subjects appear as appendices in Chapter VI.

B. EVALUATION CRITERIA

The following discussion describes the evaluation criteria appropriate for considering public financing alternatives. The criteria are: economic efficiency, equity (including income distribution effects), effectiveness, and feasibility. Due to data limitations, the level of precision that can be achieved in evaluating alternatives on these grounds has been less than might otherwise be desired. However, an attempt has been made to deal only with alternatives that are already basically both feasible and effective. Hence, economic efficiency and equity will be the criteria most often utilized.

Efficiency

The concept of economic efficiency that is operationally useful [1] requires that in achieving some desirable goal, resources be allocated at least cost to society. Various mechanisms exist for the purpose of assisting society in the pursuit of efficiency. In the private sector, the price system tends to do this, although it functions imperfectly in many respects. In the public sector, the most notable mechanism for promoting efficient allocation of resources is the budgeting process. Unfortunately, due to rigidities in the manner in which resources are transferred between the public and private sectors, alternative (opportunity) costs perceived within the two sectors are not ordinarily found to be equal, and in fact neither is necessarily equal to the true opportunity cost of society's total resources.

Resource allocation in the public sector is achieved by the many individual decisions of persons in the bureaucracy, the Executive Branch, and the Congress. These decisions are made on the basis of information and incentives available to each individual. Alternate financing arrangements differ in their ability to produce and disseminate the information and incentives ("signals") relevant to rational resource allocation.

For these reasons, and due to the data limitations, often no clear empirical ranking of alternatives can be achieved on efficiency grounds. However, rankings in terms of conceptually appropriate standards can be achieved. Features and schemes that are clearly inefficient can be identified and eliminated, and the remaining possibilities compared in a qualitative manner. The implication is that, in evaluating various alternatives, one can achieve a ranking in terms of contributions to full social opportunity costs and social benefits (as opposed to contributions only to specific groups).

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[1] It is more technically correct to define economic efficiency as requiring that, in pursuit of some goal, resources be allocated throughout society such that the excess of benefits over costs is maximized, i.e., such that marginal social benefits equal marginal social costs. However, this definition seldom has operational significance.

Equity

Another principle of social welfare is that of equity (or fairness). Conventionally, this principle is taken to mean that persons in the same circumstances should be treated similarly ("equal treatment of equals") and that those in unlike circumstances should be treated impartially. For example, certain groups should not be required to pay for programs when groups in similar positions are exempt; program benefits should not be made available to one group and withheld from another that is essentially equal. Unfortunately, available means of collecting revenues and of distributing program benefits have been much too inflexible and unresponsive to offer much promise for true individual equity with respect to government programs.

Analyses of equity effects require basic assumptions regarding the basis for judging groups "equal." Different approaches are possible, and they may lead to different conclusions. Two such approaches, widely used in the study of taxation, are the "benefit principle" and the "ability" to-pay principle." Under the benefit principle, equity is satisfied when those who receive the benefits of a government program pay the costs in proportion to benefits received. The ability-to-pay criterion holds that persons should pay the costs of a government program in proportion to their financial capability. This latter concept of equity is dealt with in the discussion of income redistribution effects below.

Income Distribution

It is rather obvious that society's resources are distributed unequally among its members. It is equally evident that distributions of income must exist which would be preferable to the one existing at any moment. Beyond this point, however, there is little agreement, even among students of welfare economics. The criteria available for identifying "better" or "worse" income distributions are so general and so dependent upon simplifying assumptions as to be virtually useless in evaluating distributional effects of actual programs. One is relegated to pointing out that Federal taxpayers who support through general taxes a Federal grant program that helps a community combat its local wastewater problem have their income redistributed to people in the recipient community.

In this context, taxing proposals can be regarded as either progressive or regressive with respect to income. Benefits from government programs may be distributed progressively or regressively with respect to income. Both progressive taxes and regressive benefits tend to transfer income from rich to poor, a result which may be found desirable. Where such deliberate transfers are indicated, selection of the financing method offers one means of achieving them. Some programs are designed specifically with income redistribution in mind (public assistance, social security, revenue sharing, unemployment compensation, etc.). With other programs, this may occur as a by-product of normal operations. In either case, redistributive effects are of interest.

Effectiveness

Effectiveness can be defined as the ability to produce a desired effect. No financing arrangement will be considered which does not possess, in some measure, the ability to finance the program in a manner consistent with program goals. Several ambiguities creep in, however.

The exact manner in which a program that is desired should be financed can seldom be specified. Programs have general objectives and, as a consequence of those objectives, immediate goals. The immediate goals may create certain financing requirements, but they may also be capable of achievement in various ways, each with its own financing requirement. It may be difficult to distinguish among financing alternatives on grounds of effectiveness unless the range of possible requirements is fairly specific.

Even where financing requirements can be stated with precision, the relative abilities of alternate financing arrangements to satisfy the requirements cannot. Since a financing arrangement consists of a relationship among individuals and institutions having dissimilar motivations, even the relative ability of alternate arrangements to meet specific requirements can only be predicted in a probabilistic sense.

The application of an effectiveness criterion to financing features, then, will lead to disqualification of all possibilities which can be judged unlikely to meet program goals.

Feasibility

The final category of evaluation criteria to be discussed concerns feasibility. First of all, a financing alternative must be politically feasible. It must be capable of attracting sufficient support to secure passage of the necessary legislation.

Even with political support, a financing scheme must possess legislative feasibility. In broadest terms, this means it must be constitutional; however, legislative feasibility can also be defined in terms of the range of existing, functioning legislation, including certain obvious extensions. Financing features which have no successful precedent in the law, then, must be considered with caution.

Once enacted, a financing scheme must be implemented. This raises questions of administrative feasibility associated with fiscal management, agency organization and administration, program management, and, in the case of new taxes, revenue collection. Once again, the major criterion must remain comparison with successful precedents. Frequently, the feasibility of a unique proposal must be imputed from the experience of unsuccessful schemes, but conclusions drawn from this type of comparison should be used cautiously.

C. SUPPORTIVE STUDIES

A number of studies were utilized in developing this Report. Several contractor analyses were funded, some directed solely to providing material needed for this Report, others serving several purposes. The most useful in the analysis were the following:

- *Evaluation of Alternative Methods for Financing Municipal Waste Treatment Works*. Meta Systems, Inc., February 1975.
- *Alternative Municipal Wastewater Systems, Standards, and Financing*. Energy Resources Co., Inc., December 1974.
- *Analysis of Cost-Sharing Programs for Pollution Abatement of Municipal Wastewater*. National Bureau of Standards, November 1974.
- *Environmental Trust Funds: An Evaluation*. RIVUS, Inc., July 1974.
- *Incidence of Alternative Financing Methods for the Municipal Treatment Facilities Program*. The Public Interest Economics Center, June 1974.
- *Review of the Municipal Waste Water Treatment Works Program*. EPA Construction Grants Review Group, November 1974.
- *Economic Analysis of Selected Features of Municipal Wastewater Construction Grant Legislation*. Marshall Rose with Jon Goldstein, Washington Environmental Research Center, Office of Research and Development, Environmental Protection Agency, forthcoming. The authors were important contributors to this Report.

D. CONTEXT OF THE PROBLEM

This discussion considers the context of the alternative generic approaches to pollution abatement that are candidates for analysis: The various pros and cons of the implementation mechanisms (regulations, subsidies, effluent charges) for improving water quality are presented.

Although environmental quality of a high level is desirable, attainment of environmental goals must compete with other desirable goals, such as increased goods and services, for the nation's limited human services. There is, therefore, a tradeoff between environmental quality and other goals.

Unlike private goods and services, individuals cannot purchase environmental quality. Consequently, public bodies and not the marketplace must determine the appropriate level of purity for the environment. However, regardless of the actual level of environmental quality that is chosen, some means must be employed to gain that level. The means would, in a generic sense, appear to be threefold: (1) The use of regulations to prescribe levels of environmental quality; (2) Subsidies to reward those who take specific action to reduce pollution, and (3) Charges levied against those who pollute the environment. Any one of the three will do the job, but with different economic effects. This section will provide a general discussion of each, pointing to the associated pros and cons. The intent is to provide an overall frame of reference for consideration of the main body of this report.

Regulations

Regulations are the simplest and most widely used form of control. Their apparent simplicity probably accounts for much of their acceptance by Congress and administrative agencies. They are also appealing in cases where some form of government intervention is deemed necessary to achieve a desired result. That is, they are viewed as buying a greater degree of assurance that the desired result will be achieved. Although there are often technical monitoring problems, the standards are known and a violation that is detected can result in penalties. Regulations usually require a large administrative force and sufficient technical expertise.

Proponents of regulations consider them the most practical and equitable form of control. Equity is held to be reached because the same regulations apply to all (i.e., they at least apply uniformly across large groups of entities). Supporters of uniform standards argue that unless the same standards apply everywhere, the rules will be neither fair nor effective in reducing pollution. Firms that are polluting in one region would move to areas where standards are lower, and firms with higher standards would be treated unfairly. Communities with high standards would be at a disadvantage in attracting and keeping industry.

However, opponents contend that requiring all waste dischargers (or large groups of dischargers) to meet the same standard does not promote efficiency or equity. Just as some polluters employ differing amounts of labor and capital, some production processes generate more waste than others. For these polluters, costs of waste treatment are higher and, in the industrial area, the economic viability of firms will differ. Hence, some firms can better afford to treat their waste than others. Furthermore, firms (and municipalities) should be permitted to discharge differing amounts of waste when the damages done by their wastes are different. Hence, the assimilative qualities of particular geographical areas and economic costs of waste treatment suggest different levels of environmental use be permitted.

The general notion is that a discharger should pay all of the costs of production, including the damages (environmental costs) it imposes. Otherwise the product it produces will be underpriced and overconsumed relative to an economically efficient level. It is difficult for regulations to promote economic efficiency because they do not provide a mechanism for the complete "internalization" of all costs.

Subsidies

Subsidies are preferred by the polluters and by some legislators because they reduce the costs of abatement that must be incurred by the dischargers (though they may increase the costs to society). In general, Federal subsidies have been given in the form of low-interest loans, grants, and special tax treatment. In addition, "implied" or indirect subsidies have sometimes resulted from regulation. This has occurred, for example, where waste treatment has been provided at less than full cost, such as where firms can avoid paying the interest component of municipal user charges.

Subsidies to municipalities have been granted to provide an incentive for them to install (or upgrade) waste treatment facilities that they otherwise would not choose to construct. Moreover, a large portion of the costs of pollution fall on individuals outside the area where the pollution originates, e.g., on those downstream. Since polluting communities tend to ignore these costs when making waste treatment investment decisions (and, hence, provide less treatment than would be desirable from society's point of view), subsidies can provide a means by which the benefits from pollution abatement that will be obtained outside a community will be reflected in the investment decision. In addition, subsidies for public treatment facilities also provide financial aid to communities otherwise unable to afford treatment.

Business firms sometimes argue that they are being forced to treat their effluent so that others may benefit, and hence that they should be compensated for the benefit. This is another form of the argument for subsidies based on property rights, i.e., it is sometimes contended that waste dischargers have over the years acquired a right to this use of the environment. Though many agree that there is an element of truth to this argument, the counter has been that businesses use up environmental assets in their production process and should pay for this use.

Some proponents of subsidies have suggested that if those who want environmental quality were made to pay for it, and producers were compensated at cost, a more "realistic" level would be chosen. That is, subsidies may be used to equalize the burden among the general public. It is contended that if this burden could be financed by a tax on the users of the environment who insist on cleanliness, it might also promote a more favorable balance among users.

The most often used (popular) argument for subsidies to industry has been that pollution control does not provide a return on investment to industry. Because the equipment is costly and often "nonproductive", a "burden" is placed on firms and ultimately on the general public. The subsidy will presumably promote pollution abatement by reducing the cost burden.

Though much of the support for subsidies has been generated on the grounds that they will promote pollution abatement, there is good reason to question whether this belief is justified. Little real incentive for industry to treat waste is provided unless a subsidy covers all costs, including a normal profit. Except for those instances in which waste can be converted into a valuable product, there is no profit motive for a firm to control pollution. Perhaps the presence of subsidies reduces industry's opposition, though this has not to date been a clear outcome.

Furthermore, since existing industrial subsidies in the form of tax relief are based on the purchase of pollution abatement equipment, waste treatment that is capital-intensive is favored. This capital bias also appears to occur in the Construction Grants Program. In any case, subsidies for capital equipment reduce its cost to the polluter and encourage the substitution of fixed for variable costs. This will not result in the achievement of a specified level of abatement at least cost.

There is another disadvantage. With subsidies that reduce the cost of purchasing pollution control equipment, there is less pressure on the polluter to find alternative ways of producing products or disposing of waste. In-process changes that reduce pollution more efficiently may not be implemented, and subsidies thus may promote perpetuation of higher polluting processes.

Effluent Charges

Effluent charges have gained their main support from economists. They can be defined as a levy on a party for using the environment by discharging an effluent into it (often depriving someone else of an alternative use of the environment).

Support for effluent charges has arisen largely on the grounds of economic efficiency, i.e., if the charges are set appropriately, they will achieve pollution abatement at least cost. Such charges bring to the attention of the user of the environment just how much the use costs in terms of the damages or burden imposed on others. Thus, the cost imposed on society by the user is more likely to accord with the contribution he makes to society in the production of goods. He is less likely to receive a gain at the expense of others.

Within the limits imposed by his income, effluent charges would indicate to the polluter why he does not get more of the use of the environment he wants: he doesn't pay the price, i.e., the full cost. More of the good may not be worth the cost. The major fault of regulatory and subsidy mechanisms is that they allow profits to be gained from delay. Causing the price of pollutants to be incorporated in the price of products through a charge provides the incentive to reduce waste by any means whose costs are less than that of the charge. By putting "price tags" on the use of the public's air and water, market-type incentives are introduced to accomplish pollution abatement.

As a result of bearing the full costs of polluting the environment, firms (or municipalities) would be encouraged to use the most economical means to abate. They would also have an incentive to achieve the abatement sooner than they would if they must comply with a regulation as of a specified future year. A good deal of flexibility occurs under an effluent charge system in that the decision as to how best to handle waste treatment problems is left up to the waste discharger. Effluent charges also have the advantage of raising revenues for the government to use for additional public waste treatment facilities, to support research on pollution abatement, or for other public services.

All of the above arguments point to effluent charges as the most economically efficient implementation mechanism for cleaning up the environment, at least in theory. The problems with effluent charges rest on very practical grounds. Those opposed to effluent charges often contend that without knowledge of each polluter's cost functions, including measurement of the environmental damages, there is no defensible way to determine what the effluent charge should be. These problems are held to be complicated by the lack of homogeneity of the pollutants themselves.

The state-of-the-art of cost-benefit analysis does not permit such detailed measurements to be made at this time. Furthermore, opponents of effluent charges hold that the monitoring and enforcement costs would likely be prohibitive. An additional (practical) complication is said to be provided by the polluter that does choose not to treat and instead pay the effluent charge. In order to meet national environmental goals, the government might feel impelled to raise the charges, move to a permit type program, or to combine the effluent fees with some mandatory standards. Such program changes can present difficult administrative and legal problems.

Proponents of effluent charges hold that, for the most part, these contentions are unwarranted. An effluent charge system can be set up based on "threshold" levels of abatement. Below a specified threshold removal efficiency, no charge need be paid. Corresponding to less efficient removal efficiencies, additional thresholds can be established. For example, for a particular pollutant, no charges might be levied for a removal efficiency above 95%; from 95%-90% abatement, a charge is levied, for percent abatement of 90%-85%, a higher charge is required, and so on. Setting these levels requires no more information than determining an appropriate effluent standard.

However, administratively, the effluent charge approach requires one additional step -- the collection of charge payments. It requires more monitoring resources than technology-oriented standards. Moreover, there is a problem as to how much the unit charges should be. In the absence of appropriate cost data the credibility of the system may be lowered by the trial-and-error procedure necessary to set the charges at levels required to achieve a desired effect. Also, in the case of municipalities, to the extent they are or will be operating under economic hardships, an effluent charge system might contribute to further erosion of a community's ability to raise funds needed for public services.

Before an effluent charge system can gain sufficient support to be implemented on a large scale, more experience is needed. An interesting development in this direction is under design in Connecticut, in which civil penalties are to be assessed on dischargers that do not comply with state pollution control standards. Formulas have been set to determine fines for firms not meeting the standards. The fines (formulas) are based on estimates of the cost to comply with the state regulations. For an alleged violation, a hearing is held to permit the firm to offer evidence as to why the formulas should not apply in its case. However, if (after the hearing) it is decided that the firm must pay the fine, then takes steps to comply, and can demonstrate the costs it has borne in complying are lower than those derived by the formulas, there is a retroactive reduction in the amount of the fine that was paid. Hence, since the costs to comply are set equal to the savings from not complying, a polluter gains no advantage from refusing to meet the standards. Once systems such as this one are proven workable over time, an effluent charge system on a broader scale may become feasible in the future.

Financing Mechanisms in Perspective

It should be kept in mind that municipalities and firms face basically similar problems. Each uses air, water, and land in ways that lower their quality for other uses. More publicity is given to the need for industry to clean its wastes and more direct Federal assistance is given to municipalities to help them clean their wastes. The Federal assistance that is given to industry comes in several indirect forms (see Chapter V) and almost never as an outright grant. Industry has, however, benefited from municipal grants in that some firms discharge part or all of their wastes through municipal treatment plants at less than the cost of treatment. This point is discussed further in Chapter IV.

The characteristics that make financial alternatives (or implementation mechanisms) economically efficient are not necessarily consistent with other institutional and social values. Therefore, the collective judgment of public officials may call for financial mechanisms that are less efficient in purely economic terms but that better reflect other social purposes that may be considered more desirable.

The existing Construction Grants Program contains both regulatory and subsidy elements, and is thus characterized by many of the pros and cons already mentioned above. Because of the lack of political support and the practical problems associated with effluent charges, it does not appear feasible to consider them as a viable option at this time. Hence, the analysis in this Report will concentrate on problems associated with the current regulatory-subsidy program, and suggestions for improvement will be constrained within this context.

III. DESCRIPTION OF CURRENT GRANT PROGRAM

Grants for construction of municipal waste treatment works are authorized under Title II of Public Law 92-500, officially designated as the Federal Water Pollution Control Act Amendments of 1972. According to Sec. 201(g)(1),

> The administrator is authorized to make grants to any state, municipality, or intermunicipal or interstate agency for the construction of publicly owned treatment works.

In addition to the enabling legislation, the grant program is further governed by regulations codified in the Code of Federal Regulations under Title 40, Sec. 35.900 et seq.

The objective of the construction grant program as expressed in EPA literature is "to assist and serve as an incentive in construction of publicly owned treatment works which are required to meet State and Federal water quality standards ." The objectives of the program are carried out by the sharing of construction costs of wastewater treatment facilities with municipalities (i.e., cities, towns, boroughs, counties, parishes, districts -- except school districts), associations, management agencies, and other public bodies created by or pursuant to state law and having jurisdiction over disposal of sewage. The permit program (National Pollutant Discharge Elimination System) serves the monitoring and enforcement function for the grant programs.

The Construction Grant Program can be viewed as broken into a financial phase and a phase concerned with conditions for the utilization of the grant funds distributed to municipalities. In the first, or financing phase, Congressionally-authorized funds are alloted to states for distribution to those projects having the highest priority within each state. This process is commonly described by the terms authorization, allotment, and project selection (of a specific community).

The second program phase incorporates the technology selection, facility design, and planning for operations that will be associated with an individual treatment system. The responsibility for undertaking actions in this second program phase rests with the local grant recipient (though the actions are subject to EPA review). This is in contrast to the authorization, allotment and project selection steps, which are the responsibility of the Federal and state governments.

Before describing the activities mandated by P.L. 92-500, it is useful to point out the issues that must be addressed by any Federal Program that might be set up to improve water quality in an efficient and equitable manner. These are:

1. What level and timing of authorizations are needed to achieve program goals?

2. How should funds be alloted t recipients to achieve program goals in an equitable and efficient manner?

3. Which generic categories of technology should be Federally supported?

4. Within the general technological categories, at what level and which types of treatment activities/projects should be Federally supported?

5. What should the relationship be between public and private treatment?

6. At what rate and for what design period should facilities be funded?

These issues would need to be addressed by any Federal financing program set up to achieve water quality goals. The answers to these questions have, for the most part, already been mandated in the Act.

In the current Federal program, Congressional authorizations are disbursed through a formula to the states and then through a state ranking technique to municipal wastewater treatment projects. The first step in this process is an allotment of the year's authorization to each state. The second step is for EPA's regional offices to distribute the funds to the projects shown on state priority lists. This includes an application and approval process by EPA that determines eligible costs and the magnitude of the subsidy payment to each municipality. This Chapter presents brief descriptions of the authorization process, allotment process, the planning and grant approval cycle, and the eligibility structure.

A. AUTHORIZATIONS

The 1972 Act provided that the Federal Government would pay 75 percent of approved local construction costs for water treatment facilities. To accomplish this, the Act granted the EPA contract authority in the amounts of \$5, \$6, and \$7 billion for fiscal years ending June 30, 1973, 1974, and 1975, respectively. These authorizations were to provide the basis for an allotment of grants to the states. In practice, outlays have been based upon estimated Needs, i.e., the estimated costs to comply with the Act. These estimates are made by the States themselves. For fiscal years 1973, 1974, and 1975, total allotments of \$2 billion, \$3 billion, and \$4 billion, respectively, were made. Subsequently, the remainder, \$5 billion, has become available for obligation to the States.

Thirty-one states supplement the Federal program with grants to municipalities. Some states also make loans available. At least one state has a statute that enables the state to pay up to 25 percent, i.e., all of the matching share, of a municipal system. New Hampshire subsidizes up to 20 percent of the local share, while Missouri pays 15 percent. The common range for the state grant share is from 10-15 percent.

B. ALLOTMENTS

The 1972 Act provided that available funds for grant awards were to be allocated among the states in the ratio of the estimated cost of constructing all needed publicly owned treatment works in each state to the estimated cost of construction of all needed publicly owned treatment works in all the states.

Computation of the ratios were to be based on a "Needs Survey," biennially revised, for public waste treatment works. Because of concern over the reliability of the 1973 Needs Survey data and the conviction that certain categories of projects were more urgent and cost-effective than others, the law was amended. P.L. 93-243 directed that the allotment of Federal funds for FY 1975 be as follows: half of each state's share is based on the ratio of the individual state's total construction needs to the total of all states' total construction needs. The other half is based on the ratio of the individual states's costs to all states' costs for the following three specific categories of pollution control facilities: secondary waste treatment plants, advanced waste treatment facilities to meet water quality standards, and new interceptors, force mains, and pumping stations. In addition, the formula provides that no state will receive less than it received in fiscal year 1972.

State allotments are available for obligation for a period of 1 year following the close of the fiscal year for which the sums were authorized. Funds remaining unobligated at that time are reallocated to the other states on the basis of the most recent allotment ratio. Funds obligated but remaining after final payment or project termination are credited to the state as an additional allotment sum.

C. PLANNING AND GRANT APPROVAL CYCLE

The method by which a municipal district comes to participate in the construction grant program begins as a relatively informal process and proceeds over time to a more structured planning, application and grant approval stage. Eligible public bodies (usually municipalities) must apply for grants through their state water pollution control office. The state office, after appropriate review (and approval), places the application on a project priority list. This list, which must be forwarded to the EPA Regional Administration, is a ranking of projects that will have priority to receive grant funds in a given fiscal year. The state priority list is thus the vehicle through which the funds alloted to individual states are committed to specific projects.

Priority lists are developed by the state water pollution control office during the one year prior to the funding of the projects. In most states, a single office is responsible for reviewing initial applications (inquiries) from local public agencies and coordinating the total state effort for water pollution control. Each potential grant application is reviewed by this office and an evaluative procedure used to determine a numerical ranking for each project. In this way, it is intended that all potential projects throughout the state will be compared together, and the most critical problems dealt with first.

Rather than requiring that the applicant request funding for the complete facility at one time, the law currently provides separate grants for each of three steps in the process. The steps are:

1. Facilities Planning, during which the applicant's problem is investigated in detail, existing facilities are assessed, alternative approaches to problem solving are evaluated, and environmental impact and cost-effectiveness studies are made.

2. Detailed Construction Planning, during which the facilities are planned, public hearings are held, and blueprints prepared.

3. Construction, during which the facilities are built.

It is much easier for a community to win approval (i. e., inclusion on the state project priority list) for a Step 1 Facilities Planning application than for the subsequent Step 2 and 3 Grants. The Step 1 grant is always a relatively small amount of money, and output from this planning process is useful to the state in helping to decide priorities for future grants.

D. ELIGIBILITIES

Construction grant funds are restricted to specific classes of technology, types of projects, and cost categories. Eligible technological approaches are limited to the collection, conveyance and treatment of waste waters. Within this technology constraint, Federal funds are further restricted by project type, i. e., certain interceptor, collector and waste treatment projects do not qualify for Federal cost-sharing while others receive only partial support. Finally, the Federal government accepts liability for only some of the system costs of eligible projects. In particular, construction grant funds are not available for operation and maintenance (O&M) costs.

Eligible Technologies

There are three technological approaches to controlling water quality. The first acts upon the water body itself. In-stream aeration and low-flow augmentation are the archetypical techniques. The second approach is to prevent, or limit, the introduction of pollutants into the water, but does not involve waste treatment per se. Examples include contour plowing, erosion-sediment control, mine sealing (acid drainage), green strips and erosion barriers, retarding structures for controlling construction site runoff, pesticide use restrictions, and the diversion of urban runoff. The third approach is to collect and treat wastewater. This technological approach will be referred to as end-of-pipe treatment. By reducing or eliminating pollutants in the effluent, end-of-pipe treatment attempts to ensure that incremental pollutant loadings are controlled.

No single technology is uniformly superior for controlling specific pollutants, nor is any effective against all pollutants. The relative effectiveness of each approach is basin-dependent. For example, on the lower Delaware, increased end-of-pipe treatment will have little effect in promoting increased dissolved oxygen (DO) because the increased waste removal has been estimated to be offset by increased system loadings resulting from increases in population. In this case, the most efficient way to increase DO to a fishable standard without prohibiting growth is by instream aeration.

Although the relative effectiveness of each technology is basin-dependent, the applicability of each is not. All are applicable to the control of some pollutants, and tradeoffs are possible. Not only do the alternative technologies differ in their applicability and effectiveness, but they also display widely varying costs. For example, one EPA study1/ of the lower Delaware estimates that achieving DO concentrations sufficient to allow migration of anadromous fish would cost $40 million per year using advanced waste treatment. If aeration diffusers were employed, annualized costs could be halved. Other studies have shown that non-point control, especially of nutrients, can achieve similar savings in comparison to waste treatment plants. Of course, in other instances, end-of-pipe treatment will achieve adequate quality at least cost. In cases of severe water quality degradation, a balanced program using all methods might be required to achieve water quality goals.

Despite the varying cost and effectiveness of these technologies, construction grant funds are only available for the end-of-pipe type of technology. Public Law 92-500 does not permit Federal funding

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1/ Whipple, Hunter, Dittman and Yu, Oxygen Regeneration of Polluted Rivers: The Delaware River, EPA, Dec. 1970.

for in-stream aeration and it discourages low-flow augmentation. While not specifically outlawed, no construction grant funds have been obligated for the control of non-point sources.

Eligible Projects

The Construction Grants Program recognizes seven project categories as potentially eligible for 75% Federal capital cost sharing. These are wastewater treatment plants, projects to correct infiltration/inflow, major sewer rehabilitation, collector sewers, interceptor sewers, projects to correct combined sewer overflows and projects for the treatment and control of stormwaters.

The EPA classifies waste treatment plants as either secondary or advanced. Secondary plants are designed to remove at least 85% of the biochemical oxygen demand (BOD) contained in collected wastewater. Advanced treatment plants typically remove phosphorous, ammonia, and nitrates as well as BOD.

Infiltration is the process by which ground water enters the collection system. Inflow refers to the discharge of water into a sewer system from such sources as roof leaders, area drains, cooling water discharges, and cross connections of storm and sanitary sewers. These two factors can signficiantly affect the flow to the treatment plant. Infiltration typically occurs through leaking joints, breaks in pipes, or improper location of collector sewers relative to the water table. EPA grants for infiltration/inflow problems are generally directed at correcting these system defects rather than constructing new collectors.

EPA regulations require a determination as to whether or not the infiltration/inflow problem of each grantee is excessive. This is necessary because infiltration can increase system flow by more than 100%. Since, in the municipal system, flow is the primary determinant of treatment plant capacity and cost, reduction of infiltration/inflow can greatly reduce treatment capacity requirements and costs.

A combined sewer is designed to serve as a sanitary and storm sewer, or as an industrial and a storm sewer. In a well designed, efficiently operated system, overflow only occurs when the volume of wastewater exceeds treatment plant capacity. Excess flow is diverted to outfall sewers and directly into receiving waters. EPA grants for the correction of combined sewer overflows are directed at correcting physical defects and improving the routing and storage of the flow within the combined sewer system.

The control and treatment of storm water potentially involves a wide range of activities. These include construction of new storm sewers, collection and storage of urban runoff, blocking catch basins, frequent street cleaning, controlled flushing of sewer systems, fine or micro-screening at discharge points, chlorination, and direct treatment. EPA has not yet funded any projects for the control and treatment of storm water.

Although a wide variety of projects are eligible for Federal capital cost sharing, there are some restrictions. Land costs are eligible only if an integral part of the treatment technology. Some restrictions are also applied within eligible project categories. Waste treatment plants built with fiscal year 1975 (and beyond) grant money must provide secondary treatment, or, where necessary to meet water quality standards, more stringent treatment. The infiltration and inflow of ground water into the sewer system must be analyzed and, when economical, corrected. Finally, Federal funds for collector sewers are only available for communities existing on or before 18 October 1972.

Because of changes in Needs Survey procedures, the 1974 "Needs" Survey indicated greatly increased estimates (over those contained in the 1973 Survey) of total funding required to meet the 1983 water quality goals. The levels went from $60.1 billion in 1973 to $342 billion in 1974. Both estimates are in 1973 dollars, and have presumably already been corrected for inflation. While the "Needs" Survey is known to include overly high cost estimates, unnecessary projects, and ineligible projects, it is the only national estimate of potential program cost by eligibility category.

Examination of the Survey results, reproduced in Table 1, shows that a single project category -- treatment and control of stormwater -- accounts for over two-thirds of the 1974 estimate. Waste treatment plants account for 8% of the total and about 26% of estimated program costs exclusive of stormwater costs. Due to differences in Survey constraints, including the fact that the 1973 Survey required independent validation of Needs, while the 1974 Survey did not, comparisons of the two Surveys by project category must be made with care.

Table 1: Total Needs (Millions 1973 Dollars)

	1973		1974	
1. Wastewater Treatment Plants	22,289		28,355	
Secondary		16,639		12,635
More Stringent		5,650		15,720
2. Correction Infiltration/Inflow	691		5,287	
3. Major Sewer Rehabilitation	N/A		7,287	
4. Collector Sewers	10,825		17,458	
5. Interceptor Sewers	13,621		17,849	
6. Correction of Combined Sewer Overflow	10,825		31,076	
7. Treatment/Control of Stormwater	N/A		235,006	
TOTAL	60,123		342,318	

Eligible Cost Components

The Construction Grant Program restricts Federal cost sharing to 75% of eligible cost components. Such eligible cost components include engineering services, initial laboratory supplies, equipment and structures. Ineligible cost components include site acquisition, overtime and bonus payments, and operation and maintenance (O&M). Eligible costs are discussed at greater length in the next Chapter, in which alternatives to the existing program structure are considered.

Conclusion

This Chapter has presented a brief description of the current program. A few additional provisions, particularly those regarding industrial cost recovery, will be described in the next Chapter.

IV. IMPROVEMENTS TO THE CURRENT PROGRAM

This Chapter analyzes improvements to the current program in the areas of allotments, technological and project eligibilities, cost eligibility (capital versus O&M), design period, grant rate, and industrial cost recovery. Where possible, implications with regard to program efficiency and equity are drawn. Though it would be far preferable to analyze the program's accomplishments with regard to the goal of achieving clean water, this is not possible because of the short history of the program under P. L. 92-500, together with the lengthy implementation period associated with construction programs.

The introduction to Chapter III mentioned those issues that must be addressed by any Federal Program that might be sent up to improve water quality in an efficient and equitable manner. Before proceeding further, it is worthwhile to point them out again:

1. What level and timing of authorizations are needed to achieve program goals?
2. How should funds be alloted to recipients to achieve program goals in an equitable and efficient manner?
3. Which technological alternatives should be Federally supported?
4. Within the technological alternatives, at what level and which types of treatment activities/projects should be Federally supported?
5. What should the relationship be between public and private treatment?
6. At what rate and for what design period should facilities be funded?

This Chapter will discuss and evaluate the current program's answer to each of these questions.

A. ALLOTMENT AND GRANT PROCESS

Since the annual appropriation of funds for wastewater treatment facilities is insufficient to undertake all eligible projects simultaneously, decisions have to be made as to how best to utilize the limited budget. This implies economic efficiency considerations should be taken into account. The justification for efficiency is self-evident: with a limited amount of Federal grant funds, it is economically desirable to induce as many net social benefits as possible.

The supporting arguments for equity are twofold. First, the 1972 Amendments were an abrupt change in legal requirements and imposed a marked increase in financial burden on many municipalities. It seems reasonable to provide differential assistance during the period of adjustment to the new statute. Second, the distribution of benefits from wastewater treatment and water quality improvement between communities is highly uneven. In some communities, the benefits are captured locally; in others, they accrue to downstream communities. Hence, in many cases, benefits are not closely related to the taxes paid and the costs borne. In these situations, equity considerations acquire additional significance.

Furthermore, a reading of the legislative history suggests that although the relative emphasis on efficiency or equity may have changed over the years, the primary objective of the cost-sharing program, the allotment formula, and the State priority systems has been to improve water quality in an efficient and equitable manner. Parts of the present program design, for reasons discussed below, are not particularly well-suited to achieving this objective.

As discussed in Chapter III, once authorizations are determined, funding is a two-stage process. The initial step is the determination of allotments, i.e., the proportion of the appropriation granted to each State. The second stage consists of the development of State priority lists; their review, revision, and approval by EPA; and the ultimate granting of project funds, generally in accordance with the approved lists.

On economic grounds, criticisms of this process center on the following three points:

1. The two-stage design results in allotments being made without reference to project benefits; monies are alloted before any consideration of state priorities, i.e., benefit-rankings, is made. Moreover, no comparison of the merits of projects is made between States. Efficient investments are difficult to achieve under such a structure.

2. State "Needs," i.e., the estimated capital costs of required projects, which are the basis for allotments, reflect neither benefits nor the cost burden of the program relative to fiscal capacity. Hence, there is no reason to expect Needs to be effective in furthering either efficiency or equity (in terms of ability-to-pay).

3. The priority systems, which are responsible for ranking individual projects according to their merits, are too subjective to ensure that appropriate investments are being undertaken.

Currently, allotments are based entirely on the concept of "Needs" -- or the capital costs required to comply with the law. The cost to each individual state of complying with PL 92-500 is estimated by a biennial EPA survey. Cost estimates are supplied by the state. However, the Needs approach is not, by itself, conceptually appropriate for achieving either efficiency or equity.

Need (or cost) is an input into the abatement process, not a measure of the output. There is no reason to expect that Needs (costs) should be correlated with the benefits of wastewater treatment. Since Need is undependable as a proxy for benefits, its use for allocating grant funds without other variables as well is not likely to promote economic efficiency.

The introduction of categorical Needs as a variable in the allotment formula in 1972 was an attempt to improve the allocation of abatement resources. Concern over efficiency considerations is also evident in the Federal guidelines to the States relating to the establishment of priorities. In formulating their priority lists, the States are directed to take account of the severity of pollution, the size of the populations affected, and the cost-effectiveness of the project. By setting the actual grant rate at 75 percent, it is further presumed that equity was considered; the implication is that this mechanism was used in an attempt to ensure that the actual burden on any community would be relatively modest. Of course, this may in fact not be the case, since the actual community cost burden will depend on the total cost of constructing, maintaining, and operating a treatment facility, and the latter two items are not now being subsidized.

In any case, Needs or the costs of wastewater treatment are not an appropriate measure of fiscal burden. Needs reflect the absolute cost burden on a community, but not the cost burden relative to fiscal capacity. Consequently, Needs alone are only a very crude measure of equity. A wealthy State with extensive Needs may be under no greater fiscal burden than a poor State with limited Needs. The use of variables in addition to Needs as the basis for allotments will be discussed further below.

The final step of the allotment and grant process occurs when the state proceeds to assign a fraction of its allotment to an individual community. This assignment is made by utilizing a project priority list, reviewed by EPA, which ranks projects according to their importance within each State, and presumably reflects abatement benefits. However, Federal allotments to the States occur without any consideration of these lists, and hence without any consideration of benefits. No project-by-project comparison occurs on a nationwide basis. In the absence of comparisons across State borders, economic efficiency cannot be achieved. In some places, relatively inefficient projects will be undertaken at the expense of socially preferable projects elsewhere.

There is also little reason to believe that projects are efficiently ranked within states. The priority lists are formulated by evaluating each prospective project according to a set of criteria. Some of the criteria are required by Federal rules and regulations, but some are established by the State. The State assigns a maximum value or weight to each criterion. A project is awarded points for each criterion, and the total points determine its ranking on the priority list.

The priority lists are supposed to rank individual projects according to such criteria as the severity of pollution, the cost of the required facilities, and the number of people who will benefit. Although not formally designated as such, the lists are supposed to serve the function of benefit-cost algorithms. It does not appear, however, that they are operating in this fashion.

Although states have criteria and systematic methods for determining the rank ordering of projects, they are basically evaluated in qualitative terms. In addition to having complete freedom in assigning weights for each criterion, the states have considerable discretion in defining both the criteria chosen by them and those which are federally imposed. There is no objectively-structured weighting scheme established nationwide to assure uniformity. Flexibility of this kind provides the states and localities with an opportunity to express their individual preferences, but it also makes it very difficult for the EPA Regional Offices to appraise the priority systems and project lists objectively. In point of fact, the subjectivity of the systems appears to be such that the Regional Offices, because of their resource constraints, have difficulty finding a basis not to approve them.

It should be noted that equity and efficiency are too dissimilar to be served simultaneously through a simplistic function dependent on only one variable. Though a simple allotment formula based on only one variable is attractive from an administative point of view, administrative convenience is not necessarily consistent with the primary program objectives. There is unlikely to be one variable that can simultaneously promote two such different objectives as equity and efficiency. These objectives can be served by splitting the construction grant appropriation into two parts: one part to be dispersed on the basis of an efficiency criterion and the other part according to an equity criterion. Based on the efficiency criterion, projects could be funded according to their urgency. Based on the equity criterion, a portion of Federal appropriations could be disbursed in proportion to the relative fiscal burden that States will incur in complying with the law. This basis for allotments will be discussed further below.

1. Allotments

This Section discusses options for the allotment/grant process. These options range from continued use of the Needs formula itself to a funding process which allocates funds on the basis of both effectiveness and equity criteria. In generic terms, the alternatives are:

- Continue the current Needs formula,
- Allotments based on variables in addition to (or other than) Needs (though the basic allotment/grant process itself remains unchanged), and
- A combined allotment and project selection system that disburses funds partly on the basis of an equity criterion and partly on the basis of an efficiency criterion.

Option 1: CONTINUE THE CURRENT NEEDS FORMULA

The present formula is quite straightforward. It is based on the single concept of estimating the costs required to comply with the law. The conceptual difficulties with this approach were discussed above. These cannot be avoided by "cleaning up" the Needs formula. However, certain administrative concerns can be addressed. At present, the allotment formula allocates the greatest share of appropriations to those states with the largest estimates of costs to be incurred to comply with the standards. The states are well aware of this, and one would expect them to protect their share of funds by increasing the cost estimates wherever possible. Also, two-thirds of the total $342 billion reported in the 1974 Survey was for stormwater treatment and control. Since there is considerable difference of opinion among experts regarding the feasibility of stormwater control and the potential benefits even if control were feasible, such speculative data should continue to be excluded in the determination of allotments.

Similarly, as has been EPA practice, the cost of ineligible treatment expenses should not influence the allotment of funds for the subsidy program. Some confusion over whether ineligible items were used to allot monies has occurred since 1974 when the states were allowed to include in their survey response all costs which potentially could be incurred to meet the long-range requirements of the Act. This was a change from the 1973 Survey, which only allowed grant-eligible costs to be included. However, for allotment purposes, the ineligible cost items, were (appropriately) not used to allocate capital subsidies. The rationale was that though it is useful to collect such information in order to improve the planning process and assist in policy formulation, having specified which items are eligible for funding, it is inappropriate to allow the cost of ineligible items to influence allotments.

A Survey practice that might appear questionable concerns the time period over which projected Needs are estimated and used for allotments. Current survey regulations direct the inclusion of current Needs for the projected 1990 population. In practice, one might wonder if this does not tend to take the form of estimating total projected Needs through 1990. This total is not time-phased into yearly or other short time periods. Total Needs through 1990 are not, in principle, an estimate of current capital requirements for wastewater treatment systems, i.e., future Needs should not be weighted equally with current Needs.

Upon examination, however, this concern diminishes. Given the limited level of authorizations, coupled with the extensive treatment requirements that must be met nationwide, the States could make a strong case that virtually all the Needs are immediate. Hence the introduction of time-phasing into the allotment/grant process becomes important only in a long run time horizon, i.e., if a grant program is continued after the backlog has been funded.

Hence, an allotment formula based on Needs is administratively attractive. The problem is that its use does not serve either economic efficiency or equity. The next sections discuss the addition of variables that, in combination with Needs, would be more conceptually appropriate.

Option 2: ALLOTMENTS BASED ON VARIABLES IN ADDITION TO (OR OTHER THAN) NEEDS

In this section, three variables will be discussed as options or additions to Needs in the allotment process. Each variable provides some contribution to equity or efficiency not present in the current process. These variables are:

- Population in addition to Needs;
- Fiscal capacity in addition to Needs;
- Population within a certain radius of water bodies in addition to Needs.

Population in Addition to Needs

Population as a factor in distributing grant funds is often used in public works programs. However, its use must be exercised with care, i.e., analysis of its ability to promote program objectives must be made because population is not the sole determinant of costs and benefits. Although the load on a treatment plant is correlated with population, the amount of treatment necessary, and, hence, the cost of abatement, is also related to the environmental characteristics of the region. The value of benefits derived from an improved water segment is related to the type of use that is to be sustained and the availability of substitutes. If a serious attempt is to be made to achieve efficiency, these additional relationships must be taken into account. For example, in order for state population to be an accurate indicator of the benefits received as a result of wastewater treatment projects, account should be taken of the population's proximity to water. In each state, some portion of the population lives and works on or near major rivers, lakes or seashores, and the rest of the population lives away from these areas. The major beneficiaries of clean water are those segments of the population with the access to water. Thus, if a direct relationship with population is used to distribute funds, states with large populations and limited water would receive large allotments. States with abundant water, polluted from (say) mining operations or pulp mills, but with sparse population, would receive limited allotments (and, of course, no funds for stopping pollution from flowing into the next state). State population does not provide a specific insight as to who benefits from the investments nor who bears a disproportionate cost burden.

The inclusion of a population variable in the allotment of funds does tend to satisfy the benefit principle of equity: States with large populations, which tend to pay more Federal taxes than do states that are less populated, would receive a greater Federal share of funds (and, presumably, tend to receive relatively more benefits from the ensuing water cleanup).

However, based on the ability to pay concept, use of state population as a variable to allot monies does not necessarily contribute to equity. Population by itself is not an indicator of fiscal capacity: The number of people in a state is not necessarily related to municipal debt capacity, the tax base, personal income, or corporate income. There is no reason to assume that using population as a basis to allot funds to states will achieve an equalization of financial burdens imposed by the Law.

In addition to the above points, care must be taken to assure that, in practice, spurious results do not occur from the introduction of the population variable. Such effects depend in large part on the particular function that is chosen. For example, population and Needs can be used as separate (additive) variables in the formula or can be combined in a ratio. The ratio of Needs/population for a state is the per capita cost burden in that state. If this ratio were to become the basis for allotments, then for a given level of Needs, a less populated state would receive a relatively higher proportion of funds. This is unlikely to promote efficiency "across the board." Furthermore, with this ratio, there is every incentive for states to continue to overstate Needs in order to maximize their allotments.

If the above ratio were inverted, i.e., utilization of the ratio of Population/Needs, the incentive to overstate needs would be eliminated. The greater the estimate of Needs in the denominator, the lower the ratio. The tendency to understate Needs to increase the ratio (and thus allotments) could be taken care of by stipulating that each state would receive the lesser of (1) its share of monies based on the ratio of population/Needs for its State to the total population/Needs for all states, or (2) the absolute amount of the state Needs as expressed in the denominator of the state ratio. These results might, on the surface, appear to be desirable enough to suggest adopting this ratio as superior to the existing allotment formula, which is based on Needs alone. A problem arises, however, when one analyzes the effect of the denominator separately from that of the numerator. The effect of alloting funds on the basis of the inverse of Needs, 1/N, is to grant less monies to the "neediest" states. This would hardly seem consistent with Congressional wishes. It is, of course, possible that the population variable in the numerator "compensates" for this tendency. Without empirical examination of the effect of using this ratio, however, one cannot recommend its use. The additive form (population plus Needs) does not run into this difficulty.

The foregoing discussion does not mean to suggest that use of a population variable does not have desirable economic characteristics. State population can be a valuable variable in the allotment process, but further refinement should be considered for the long run. These refinements are treated in subsequent sections below.

Fiscal Capacity in Addition to Needs

Prior to PL 92-500, fiscal capacity was used in grant formulas to take equity (in this case, ability to pay) into account in the allocation of funds. It was presumably not included in PL 92-500 because the 75% grant rate was deemed sufficiently high to ensure that the local share would not result in an excessive burden. However, now that the program has been in operation for several years, to the extent that the burden of the program on local governments is expected to be severe, introduction of a fiscal capacity variable may be a reasonable method to achieve a more equitable distribution of funds.

The two indicators of a State's fiscal capacity most often used are per capita income and total personal income. Other measures, such as the statutory tax base and tax revenues, are not accurate indicators of fiscal capacity, because of considerable variations in state methods of taxation and bases for tax valuation. Furthermore, the potential tax base, not the statutory tax base, is the appropriate concept. The fact that a State has sources of revenue that it chooses not to tax should have no bearing on the choice of a basis to allot equity funds. However, neither per capita income nor total personal income by themselves are completely satisfactory measures of a State's fiscal capacity (though they are both relevant to determining a State's ability to bear program costs). A state with a relatively high per capita income but a small population could be seriously burdened by abatement costs because it has a small tax base. Thus, a total rather than a per capita concept is appropriate. However, in a State with a large tax base, the burden on individual taxpayers could nonetheless be substantial, simply because the base is comprised of a large population with a low per capita income.

A concept that avoids the disadvantages mentioned above is total personal income in excess of a specified income level, e.g, the poverty level. States with a large, low-income population would be accorded a relatively low fiscal capacity under this definition, as would States with a high per capita income, but a small population. Of course, there are tax bases other than personal income that might be included in a fiscal capacity measure: personal wealth, personal and corporate property, and corporate income. Personal and corporate property information are available by State, but estimating personal wealth and corporate income would pose considerable statistical problems.

One additional point should be made. Fiscal capacity alone is not the relevant variable to use to promote equity. The appropriate concept is the cost of abatement (Needs) relative to fiscal capacity. A wealthy State with extensive Needs may be under no greater fiscal burden than a poor State with limited Needs. Consequently, the cost burden to be borne in relation to the fiscal capacity variable will ensure that funds are distributed equitably.

The most difficult problem to address is the importance an equity variable (or equity function) should have in the allotment of funds. The purpose of distributing some portion of monies based on an equity criterion is to provide greater relative fiscal relief to those communities experiencing a disproportionate wastewater treatment burden. Additional information regarding the difficulties being encounted by municipalities in raising funds to meet the requirements of the Act is needed before a "weight" can be assigned to an equity criterion. However, it is fairly obvious that the advisability of distributing funds based on an equity criterion is diminished the higher the grant rate.

Population Within a Certain Radius of Water Bodies in Addition to Needs

Earlier in this section, population by itself was found only partially suitable as a basis for alloting funds because people and water are not always located together. However, it is possible to suggest a refined population variable that could serve as a benefit surrogate: The population that lies within some specified radius (say, 100 miles) of the water segment that is to be improved. Actually, the value of the benefits derived from water quality improvement depends largely on the type of use the water body will receive, the amount of use (the number of user-days), and the availability of substitutes. Other things being equal, larger populations generate greater uses of water, and persons living close to an improved water segment should benefit from it more than those living farther away.

Since a goal of PL 92-500 is for grant recipients to take receiving waters from existing quality to a quality suitable for fish and for recreation other than swimming, recreational benefits are of primary interest. There are numerous types of recreational activities, and they are unlikely to be of equal value. Despite this, the only practical method of dealing with these alternative uses is to assume no matter what the specific form of activity (fishing, boating, aesthetic enjoyment), all man-days of water recreation are equally valuable. Moreover, direct estimation of the number of man-days of use that each water segment will generate is complex, costly, and unlikely to provide satisfactorily accurate results. Hence, the most practical proxy for amount and type of use appears to be the population within a specified radius of the water segment to be improved.

The availability of substitutes can be accounted for by the stock of comparable quality water segments within the specified radius of the improved water segment. Inclusion of this variable requires several simplifying assumptions regarding homogenity of water bodies and the corresponding activities that take place near the water bodies, non-water activities, and the like. Nevertheless, the stock of comparable quality water appears to be a practical variable, and data on it should be available. There are a number of ways to measure the stock, but none is completely satisfactory and free of difficulties. Length (in terms of stream-miles) or circumference (in the case of lakes) is one concept that might be considered, and will be used in this Chapter for illustrative purposes.

The collection and use of the data mentioned above should be attempted to determine to what extent it might be available without a massive effort. In the preparation of annual priority lists, each State is required to assess water pollution problems in the State. In ranking State water segments, account is taken of the severity of pollution, population affected, need for preservation of high-quality waters, etc. With this in mind, the kind of information needed to inject of economic efficiency into the allotment process may well be available with a reasonable amount of effort.

Of course, without testing several variables (and functional forms) incorporating the concepts mentioned above, it is not possible to anticipate the results of alloting funds on these bases. However, it is anticipated that an effort to identify data collection problems and to determine the effects of distributing monies on the basis of alternative formulas will be undertaken in the near future.

Option 3: COMBINED ALLOTMENT AND PROJECT SELECTION SYSTEM

As mentioned earlier, features of the current funding process that conflict with the efficiency and equity objectives of the program cannot be adequately corrected by a single (and simplistic) function based on the costs to comply with the Act (Needs). Equity and efficiency are too diverse to be served by one function. In this section, an alternative allotment formula and funding process is discussed that avoids the conceptual problems of the current process. Without addressing how much of the Construction Grant appropriation should be allocated based on an efficiency criterion and how much should be allocated based on an equity criterion (this can only be determined by the Congress), separate criteria for funding projects based on efficiency and for disbursing funds to States in proportion to the relative fiscal burden that States incur in complying with the Act are developed. Because of the necessity to perform additional empirical analysis, it is anticipated that these criteria can only be offered for consideration in the long run.

The Efficiency Criterion

The state of the art of benefits analysis precludes any attempt here to estimate the value of wastewater treatment benefits and use the results to aid in alloting funds. An alternative approach is cost-effectiveness analysis, which uses non-monetary output variables to form an index of benefit surrogates. The output variables chosen depend on the objectives of the program. Because an effectiveness index is not measured in monetary terms, it is not possible to net out costs, to account for supplanted activities, or to discount the value of future outputs to the present. Though an effectiveness index is a conceptually less accurate measure of the value of a project than net benefits, it is preferable to the existing priority system.

It would be desirable to have an effectiveness index that distinguishes between types of uses (because not all uses are equally valuable), and takes into account amounts of use and the availability of substitutes. These factors reflect the value of benefits derived from water quality improvements. The earlier discussion regarding the use of a population variable that takes proximity to water bodies into account is also applicable here, and will not be repeated. That discussion pointed out that such a population variable is the most practical for measuring amount and type of use. Similarly, the availability of substitutes can be taken into account by including the length or circumfernce (in, say, stream-miles) of the stock of water within a specified (100 mile) radius.

Although an infinity of possible functional forms exist for the effectiveness index (E), there is no way to determine which form will generate the best approximation of net social benefits. Initially, a form is presented that is uncomplicated, ranks projects in a desirable manner, and is based on variables whose values can be estimated.

Let $E = P^a (P/W)^b \ (dW/W)^c$,

where P = the resident population within a 100 mile radius 1/ of the improved water segment,

W = the stock of water (measured in stream miles) within a 100 mile radius and comparable in quality to the improved segment,

dW = the length of the improved segment, and

a, b, and c = scalar parameters.

dW/W is the percentage change (improvement) in the area's stock of water that is generated by the investment in the treatment project. For a given dW, this statistic will have a smaller value in relatively water-rich regions, and will produce an effectiveness index having a smaller value than it would be in more arid regions.

P/W, the population per stream mile, is a density variable. It provides an indication of how crowded the area's recreational water facilities are likely to be. If the region is rich in water relative to the population, E will tend to be lower than if the region has a meager stock of water.

If one considers two areas with identical values for P/W and dW/W, but with one area more populated than the other, more benefits are likely to be generated in the area with the larger population because more people will be using the water. The above functional form for the effectiveness index reflects this, since E increases with P.

The parameters a, b, and c are discretionary; they should be explored by empirical analysis and established by Congressional action. By altering the size of these parameters, one can alter the relative impact of the variables P, P/W, and dW/W on E.

Of course, E is only the numerator of the effectiveness-cost index. Eligible capital cost (K) 2/ constitutes the denominator. For a given level of effectiveness, a higher capital cost reduces a project's effectiveness-cost ratio (E/K) and thus the likelihood that it will receive funding. This is appropriate, since, with a limited appropriation, those projects should be undertaken that will maximize the summation of the E's, i.e., maximize the aggregate effectiveness.

1/ Though the choice of any geographic limit is somewhat arbitrary, a 100-mile radius is not an unreasonable distance to expect travel to occur in order to gain recreational benefits from water.

2/ Eligible capital cost is used rather than total project costs because funding should be on the same basis as the costs supported by the program.

The above discussion has presented one option for an effectiveness-cost index. It has some appealing characteristics: it ranks projects in a manner consistent with improved resource allocation, and is based on variables that can be estimated. However, a cost-effectiveness (or effectiveness-cost) ranking scheme represents a major structural change from the existing funding process. It is important to examine the administrative feasibility of this option relative to the present system of allotments and priority systems.

The initial reservations about an allotment system which requires a cost-effectiveness analysis for all proposed projects and distributes funds based on the relative rankings of projects are that is seems like a radical, complicated departure from the present program design, and that it might increase administrative expenses.

The present construction grant program requires analogous project evaluations. Currently, states have to make cost estimates for proposed projects when completing the Needs Survey and in the process of developing their priority lists. Hence, the cost-effectiveness scheme should not involve an additional burden with respect to costs. The other tasks that are performed (e.g., the annual assessment of water pollution problems; a ranking of state water segments, taking into account severity of pollution affected, need for preservation of high-quality waters, and other national priorities; and an explanation of its criteria for project selection) are similar to the kind of analysis needed to identify (say) the length of an improved segment. Thus, substituting a cost-effectiveness ranking procedure for the current program requirements would not appear to involve a radical increase in administrative cost. Though the quality of the data that is currently estimated during this process may be a problem, States have to conduct these activities now.

Since the cost estimating procedures would be virtually unchanged, cost-estimation itself might not be a source of increased administrative expense. The availability and estimation of data should be explored to verify whether or not this is the case. Certainly, if the above efficiency criterion were instituted, an increase in the accuracy of the estimates could be expected. The present incentive for States to bias their cost estimates upward solely to protect their share of allotments would be eliminated. With an effectiveness-to-cost ratio, if they continued to overestimate their costs (the denominator) in an effort to obtain greater funding, the States would jeopardize the ranking of their projects. If they underestimated their costs (Needs) in order to improve the project rankings, they would jeopardize the size of their grant. Hence, every incentive would be to estimate cost in an efficient manner.

For long-run implementation, one of the problems that must be overcome is that of time-phasing. Because a dollar ten years from now is less valuable than a dollar today, future dollars, in order to make them comparable to current dollars, have to be "discounted" over time using an appropriate interest rate.

In its present form, the effectiveness-cost index suffers from this problem. Wastewater treatment projects generate benefits over a time span, and the annual benefits may not be uniform throughout the life of the project. Consequently, though it is not apparent which year's statistics to use in evaluating the stock of water, user population figures based on Census growth projections could be utilized each year in the numerator of the effectiveness-cost index. The denominator should then incorporate time-phased (preferably discounted) Needs estimates.

Furthermore, since the essence of discounting is to create comparability between benefits in different time periods so as to avoid committing too much capital to projects whose benefits are not realized for some time, a procedure that utilizes time-oriented eligibility criteria would be helpful. The criteria could be used as a screening device to reduce the number of projects eligible for inclusion in the effectiveness-cost ranking. For example, preference could be given to projects necessary to meet some future year's standards, and projects not expected to be operating and producing benefits within (say) 5-6 years might rank low in priority.

Equity Index

The purpose of distributing a portion of the funds on the basis of an equity index is to provide some fiscal relief in those communities where the 1972 Amendments imposed a disproportionate financial burden. The data requirements for an equity index make it very difficult to develop an index at the community level. Consequently, an index is considered to distribute funds among the States. The implications of this for achieving equity among communities is discussed later.

Earlier in this Section, in the discussion on considering Fiscal Capacity in Addition to Needs, the point was made that program cost relative to fiscal capacity is generally a better indicator of burden than either cost or fiscal capacity alone. Moreover, just as with the efficiency criterion, for the long run, the sum of (undiscounted) current and future capital requirements is not an appropriate statistic to use in determining either the current burden on a State or the distribution of the current appropriation. Current capital requirements is the relevant concept. 1/ With the existing grant rate, the estimate of capital costs to use in the equity index for each State is 25% of total current grant-eligible capital costs funded under the efficiency portion of the appropriation.

As discussed earlier in this section, the fiscal capacity concept that is appropriate is the potential, rather than statutory tax base. The fact that a State has sources of revenue that it chooses not to tax is not relevant to its actual fiscal capacity nor to the determination of how to distribute

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1/ Operation and maintenance expenses are also a burden imposed on communities by the 1972 Amendments. However, research has shown that, in the aggregate, these expenses are approximately proportional to the capital costs of a project. Consequently, their exclusion will not alter the relative financial burden incurred by communities.

equity funds. The variable that avoids the disadvantages of both per capita income and total personal income, but retains the fiscal capacity information inherent in both of them, is the sum of personal income of all those persons above some specified low income level, e.g., above the poverty level. States with a large low-income population would be assigned a relatively low fiscal capacity under this definition, as would states with a high per capita income that have a small population. The need for equity funds for each state is, therefore, based on the ratio of current capital costs of abatement (time-phased Needs) to fiscal capacity for the State.

There are numerous functional forms of the equity index. One option is to base each Statebs share on the proportion that each State's Needs/fiscal-capacity ratio is of the sum of all States' Needs/fiscal-capacity ratios. This gives a measure of the fiscal burden of wastewater treatment in each State relative to the burden in all states. States with a relatively high burden would receive more equity funds than those with a low burden.

Because the necessary income information is available from the Census at the State level, but is difficult to obtain for municipalities, a State rather than a municipal equity index is more feasible. Because of the discretion that could be exercised by each State in distributing these funds to municipalities, some review responsibility at the national level is probably advisable. In order not to interfere unduly with the efficiency criterion, a limit could be placed on the amount of Federal funding any one project could receive. In this way, local communities would still bear a part of the cost of abatement and would retain some interest in cost minimization. However, even without Federal involvement, equity is likely to be served in part, because the funds are allocated to the States based on the relative burdens they are experiencing.

In the presence of the 75% Federal capital grant rate and the additional grant aid that is available to communities from some States, the need for equity funds may not be severe. This merits further analysis. To the extent that there is interest in distributing funds based on an equity criterion, the importance (weight) of the criterion can only be determined by the Congress.

Conclusion

The current allotment process could be improved to better serve both equity and efficiency. Several other bases for allotment of monies that include variables in addition to Needs have been presented. Without empirical analysis, it is not possible to determine the distribution of funds under these other formulas. This should be subjected to analytical scrutiny in the future.

In concept, the funding process can be significantly improved by splitting the wastewater treatment appropriation into two parts: one part to be disbursed on the basis of an efficiency criterion and the other part according to an equity criterion. Assuming that the program continues to be one in which only capital is subsidized and cost shares are uniform, the efficiency criterion that maximizes net economic benefits is: rank all proposed projects according to their net economic benefits relative to capital cost, and fund them sequentially until the efficiency portion of the appropriation is exhausted. Because it is difficult to estimate and monetize the benefits from water quality improvement, a cost-effectiveness approach was discussed. In this approach, variables are combined into an effectiveness index, and projects are ranked and funded according to their effectiveness-cost ratios.

An equity index was presented based on program cost relative to fiscal capacity. The proportion of the equity appropriation that a State receives depends upon the fiscal burden of wastewater treatment in that State relative to the burden in all States.

Because of the necessary analytical and administrative preparation that must take place before such efficiency and equity criteria as discussed above could be implemented, these ideas are offered as possibilities for the long run. In the meantime, allotment of monies to the States might better serve efficiency by the addition of a population variable to the existing distribution based on Needs alone.

B. GRANT CONDITIONS/ELEMENTS

Technological, project, and cost eligibilities, together with the grant rate, design period, and industrial cost recovery provisions, constitute the basic elements and conditions for making grants to communities. Hence, these grant conditions and elements provide the instruments by which the Federal government promotes an effective, efficient national program. The grant program should motivate the community to design the most efficient facility and to operate it efficiently over its life-span. However, critics of the current program suggest this is unlikely to occur for several reasons:

- The current eligibility structure leads to an inefficient distribution of limited Federal funds among alternative technologies and project categories.
- The high grant rate, coupled with the application of the rate to capital costs alone, creates a capital bias.
- There is little incentive provided for promotion of efficient facility performance.
- The policy with respect to treatment plant and interceptor design period often creates incentives to build excessive capacity.
- Industrial cost recovery provisions create inequities and a further capital bias.

Each of these points is addressed in the discussion that follows:

1. Eligible Technologies and Projects

Eligible Technologies

The restriction of technological eligibility to end-of-pipe treatment is, in principle, inefficient in the context of cost sharing. That is, the cost of achieving given ambient quality for some stretches of water is said to be increased beyond an economically-efficient level. This is because the benefits from improved water quality per (final) dollar of expenditures are not equalized among technologies. However, in practice, and in the presence of existing constraints, this assertion should be modified. For example, (1) in-stream technology may supplement, but does not substitute for, end-of-pipe treatment, (2) nonpoint technology is, for a wide range of applications, technically unproven and burdened with extraordinary implementation problems, and (3) the cost-effective implementation of in-stream and nonpoint source technologies in conjunction with appropriate end-of-pipe treatment requires regional management, e.g., basin planning, authorities with unprecedented decision-making and taxing authority. In addition to the powers of Section 208 Management Agencies, the required regional management authorities, in order to achieve least-cost pollution control, would require the power to impose effluent loadings, capital investments and taxes and fines on municipalities, firms and individuals.

Each of the above points will be discussed in order. First, in-stream technology by itself is too restricted in its application to provide an effective, flexible means of achieving national water quality goals. Low-flow augmentation is only a temporary, emergency technology. It simply cannot assure that high levels of water quality can be achieved and maintained. In-stream aeration is only effective against BOD and resulting low levels of dissolved oxygen. Since treatment plants can remove toxics, heavy metals, and other chemical pollutants as well as BOD, in-stream aeration is not a substitute for treatment plants. In-stream aeration can, of course, provide a supplement to waste treatment, but generally this is the exception rather than the rule.

Second, it is sometimes suggested that Federal eligibility restrictions may be inconsistent with attainment of the 1983 water quality goals. Specifically, without additional Federal, State and private efforts to control non-point sources, the 1983 goals cannot be met in the most severe water quality problem areas. In many segments, pollutant loadings from agricultural, forestry, and construction activities are sufficiently large to preclude attainment regardless of the investment in wastewater treatment. Acid drainage, especially from abandoned mines, will continue to be a serious problem in Appalachia, Illinois and Ohio. In such segments, once the substantial technical, monitoring, and other problems can be resolved, Federal expenditures for the purpose of attaining 1983 standards should be supplemented by efforts to control nonpoint pollutants. However, despite the potential cost-effectiveness gains that are (in concept) available from an optimal mix of alternative technological approaches, there are sound reasons at the present time for restricting Federal support primarily to end-of-pipe technology. As discussed in Appendix B, there are serious economic, legal and technical difficulties associated with the control of nonpoint source pollution. Until these problems are resolved, nonpoint technology is a promising but essentially unproven (and, in some applications, infeasible) means of improving water quality.

Third, in practice, realization of potential cost savings from broadening technology eligibilities is seriously impaired by the necessity for powerful regional planning, control and financing institutions. Simply broadening eligibilities will not induce individual communities to choose approaches consistent with least cost alternatives for basins, or basin segments, as a whole. This is the case because community actions (though not necessarily the prior decisions) are interrelated. Because the technology chosen by upstream communities has varying effects on pollutant classes, the downstream pollutant may well vary, as will the required downstream treatment control costs. Unless each community correctly assesses the system-wide impact of each of its alternatives, and weighs external system costs equally with its own, each will be lead to suboptimal choices. As a result, it is possible that the simple broadening of eligibilities could, in practice, stimulate local actions that are less economically efficient from society's point of view than those currently obtained. Regional planning, control, and financing institutions, more powerful than might be achieved by many 208 planning and management agencies, are required to resolve these problems.

In addition to the foregoing, a very powerful institutional barrier to unconstrained consideration of alternative technologies may be found in the 1972 Act itself. Short of a major change, the levels of funding (authorizations) and relatively short time horizon for compliance with the high effluent standards set in the Law, together with the emphasis on plant treatment, tend to preclude emphasis on grants for other kinds of techniques (such as wasteflow reduction). Communities are dissuaded from independently employing in-stream and selected non-point technologies because (1) pollution permits are directed at effluent rather than ambient quality, i.e., because of the Act's emphasis on effluent quality, localities could invest in such technologies and still be in noncompliance, (2) they are more costly to the locality. Unless the Federally unsubsidized technologies cost less than 25% of equivalent (in terms of achieving a level of ambient quality) end-of-pipe treatment, it is cheaper for the community to opt for end-of-pipe treatment. Finally, (3) capital-intensive waste treatment works appear to have a larger local employment impact. Consequently, Federal funding and legal constraints can bias community choices from least cost (though Federally unsupported) to higher cost programs for the nation.

Hence, while it is, in principle, possible to reduce the overall cost of achieving 1983 water quality goals by broadening technological eligibilities, such a suggestion is unrealistic in the light of existing real-world constraints.

Eligible Projects

In order to obtain overall efficiency and maximum water quality improvement in the context of a Federal governmental structure, limited Federal funds must be allocated among project categories so as to reflect both their relative cost effectiveness and the local response to Federal funding. In particular, if two project categories are equally cost-effective, but the first would be adequately supported by local government in the absence of Federal support, while the second would not, then Federal funds should be primarily concentrated on the second category. Similarly, Federal funding of certain project categories is inefficient because it reduces the funds available for more cost-effective projects that would not be constructed in the absence of Federal support.

These latter projects include waste treatment works, correction of infiltration and inflow, and, under certain conditions, combined sewer overflows and interceptors. The consequences of a broadened project eligibility structure include the possibility of an increased Federal commitment, delayed achievement of water quality goals, and program inefficiency.

Before considering the merits of changing Federal financial support for certain project categories, it is helpful to review the difficulties associated with achieving more efficient resource allocation in the context of a Federal Government system.

Economic efficiency in the context of cost-sharing requires that the incremental benefits from improvement in water quality per (final) dollar of expenditure be equalized among projects, i.e., economic efficiency requires that projects be funded in order of their cost-effectiveness until funds are exhausted. This implies a national ranking of all project priorities. That is, the efficiency criterion is applicable to ranking projects both within and across communities. While this is good in theory, it ignores practical political realities associated with State and local jurisdictional boundaries. In other words, the above efficiency criterion generally provides insufficient guidance for the obligation of Federal funds under existing governmental constraints because it ignores local responses to Federal cost sharing. Because the Federal Government does not initiate all wastewater projects, attainment of overall efficiency requires that Federal project obligations account for the probable reaction of local governments. For example, suppose that communities would fund the first tier of cost-effective projects in the absence of Federal participation, but would voluntarily fund certain others only with Federal cost sharing. In this case, the impact of Federal expenditures would be greatest when directed to the less cost-effective projects (less relative to the hypothetical national ranking). Otherwise Federal funds would only substitute for local expenditures without any additional improvement in water quality. Hence, overall efficiency may be reduced if Federal expenditures, when viewed in isolation, are "efficiently" allocated among projects.

In communities in which certain projects have local benefits (e.g., community growth and development) external to water quality improvement, local project priorities may be inconsistent with efficient attainment of water quality goals. In such cases, partial Federal funding can increase program inefficiency by providing facilities that are unnecessary for (or that actually hamper) the attainment of water quality objectives.

The foregoing suggests that, in order for Federal funds to have the greatest impact on improving water quality and the least adverse affect on overall efficiency, project eligibilities must be structured to reflect not only the cost-effectiveness of individual project categories, but also the local response to Federal funding of the various project categories and the constraints on total Federal monies available.

A problem which may interfere with efficient choice of projects is the use of sewerage systems as growth management tools. Some communities are using their authority with respect to sewage disposal as a substitute method of controlling other community development, such as the influx of population. In the words of the chairman of the Fairfax Board of Supervisors, "We've used sewers as a growth management tool. It's a bad one, but it is the only one we're had."[1] Another example is provided by the Northern Virginia Conservation Council, which recently requested EPA to halt any further expansion at four of the Washington area's major sewage treatment plants. According to the Council, a major reason for its action was that "their enlargement would lead to more growth in the area, which they consider undesirable."[2]

Sewer construction can also be used to *encourage* local development of undeveloped or partially-developed land. For example, an explicit goal of a $42 million Federally supported interceptor project on the South Richmond section of Staten Island is to encourage residential housing development. The city government of New York views this area of Staten Island as its last remaining land resource for moderate density development and as an addition to the tax base:

> The approval by the Federal government to let the city go ahead with the upgrading of the plant and their commitment for funding will permit the development of the southern part of Staten Island. It will spur the development of the part of Staten Island not readily feasible for home building.[3]

A side effect of (perhaps a stimulus to) the use of waste treatment facilities to promote growth is the possibility of "windfall profits" accruing to land speculators and developers, who can avoid considerable construction costs if located close to waste treatment facilities. This problem has been most often voiced with respect to interceptor projects, which have a much larger impact on property values than do treatment plants.

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[1] *The Washington Post*, March 27, 1974, Sec. C., p.1, Col. 1.

[2] *Washington Star-News*, January 27, 1974, Sec. B., p. Col. 3.

[3] *The City of New York* Environmental Protection Administration, Office of the Administrator, *Press Release*, August 3, 1973.

Whether the local objective is to encourage or discourage growth, local decisionmakers may resist a tie-in with a regional treatment system (or resist other solutions) that would eliminate or reduce their basis of control. It was reported recently, for example, that the Prince William (Virginia) County Board of Supervisors was considering building its own treatment plant rather than participate in a regional effort now underway, despite estimates that costs would thereby be quadrupled. The reported rationale was that "the regional plant would remove control of sewer line construction and operation -- and thus of growth -- from the county.[1]

The following discussion first considers the arguments for the two project categories most clearly requiring Federal assistance, i.e., waste treatment plants and correction of infiltration and inflow, and then presents the arguments for and against eligibility for other project categories.

Waste Treatment Plants

The construction and efficient operation of waste treatment plants constitute the heart of the construction grant program.

State and local governments have, of their own volition, made impressive advances in extending treatment. Between 1948 and 1973, the number of persons receiving sewage treatment services increased by 117 million, while the population as a whole increased by only 65 million. Table 1 shows that, through 1973, the "net average annual increase" has itself been rapidly increasing; furthermore, current population projections imply a halving of future annual requirements to achieve adequate coverage.

Table 1. Growth of Treatment Coverage
(Millions of persons receiving waste treatment service)

Period	Increase in Population Receiving Treatment	Population Increase	Net Increase	Net Av. Annual Increase
1948-57	29	26	3	0.33
1957-62	27	15	12	2.4
1962-68	28	12	16	2.67
1968-73	30	12	18	3.6
1973-90	50.1-62.4 [3]	36 [2]	14.1-26.4	0.8-1.5

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[1] The Washington Post, February 5, 1974, Sec. C.

[2] Census Series E

[3] The upper and lower bounds of the range correspond to 85% and 90%, respectively, of the population being sewered by 1990. Also, each projection assumes that the 4 million persons now sewered, but whose wastewater is not receiving treatment, will receive treatment by 1990.

The difficulty with state and local efforts occurs with respect to quality of treatment. Though treatment coverage has increased, the degree of treatment has generally been inadequate. Table 2 shows the trend in treatment levels. Secondary treatment is defined in terms of process, e.g., trickling filter and activated sludge, rather than in terms of the more stringent removal efficiency definition used by EPA. Consequently, this table considerably understates the population receiving less than EPA-defined secondary treatment.

Table 2: Quality of Treatment (Million of Persons)

Year	Population Receiving Some Treatment	Secondary or Better	Less Than Secondary
1948	45	22.7	22.3
1957	74	43.3	30.7
1962	101	61.2	38.8
1968	129	85.9	43.1
1973	159	105.9	53.1

There are at least three explanations for the historical difference between the extent of coverage and the degree of treatment. The first is that communities cannot afford higher treatment levels. Treatment costs often rise rapidly with increased removal efficiency. Rather than provide no treatment, communities at least attempt to reduce pollutants that are an immediate threat to public health. The second is that natural assimilative capacity is sometimes sufficiently high to allow low treatment levels. This is partially reflected in the very low quality treatment found in the Northeast and Eastern Seaboard in comparison to the much higher quality treatment found in the Southwest. Finally, communities tolerate low quality treatment because of external effects: For example, a community might be willing to fund improved treatment, but does not do so because increasing its treatment will not improve water quality unless upstream communities fund similar efforts. Regional cooperation is difficult to achieve, and any one community may not find it beneficial to increase its treatment expenditure to benefit another community. Thus, a community may ignore the downstream effects of its treatment. Hence, the Federal government must step in to mitigate the effects of local funding problems and of community actions based only on a local perspective. In order to offset the adverse overall environmental effects brought about by the influence of these factors on local decisions, the Federal government, through the grants program, has reduced the local cost of complying with pollution control regulations. The intent is also to encourage consistency between local choices and national objectives regarding wastewater treatment levels.

Ideally, EPA could further increase the overall impact and efficiency of Federal expenditures by only funding that portion of a waste treatment project that would not have been voluntarily funded by the community. However, this is not feasible: There is no current capability to separate the proportion of individual community expenditures that would be funded in the absence of Federal funding from the proportion that would not. Moreover, the potential cost savings from such an effort appear to be extremely small. A major proportion of facility cost appears to be due to the necessity for increased removal efficiencies, i.e., due to meeting Federal and State standards, and not to increases in flow. Hence, it is reasonable to conclude that most of the increased expense for treatment plants would not be voluntarily funded by communities.

Though there is undoubtedly some substitution of Federal for local expenditures in wastewater treatment plant projects, it would seem that the potential efficiency and impact losses are small enough that there should be little question as to the advisability of retaining treatment plant eligibility.

Infiltration/Inflow

The case for continued infiltration/inflow analysis and eligibility for Federal cost-sharing is that (1) communities do not generally fund these efforts on their own, (2) such analysis and projects must be undertaken to insure economical treatment plant sizing and operation, and (3) exfiltration, caused by the same physical conditions as infiltration, pollutes ground water and, in some cases, surface water segments.

The infiltration/inflow analyses themselves are generally inexpensive in comparison to the cost of treatment plants and collector systems. In addition, since correction of infiltration/inflow occurs only after analysis shows that correction is cheaper than additional treatment plant or collector capacity, there is a built-in-cost-effectiveness check on such projects.

Control/Treatment of Stormwater

There is little doubt that urban stormwater runoff is currently a significant source of pollution in many stream segments. Not only does urban stormwater contain large quantities of BOD, suspended solids, phosphates, nitrogen, and COD, but it is also the major carrier of many heavy metals (such as lead and mercury) and organic chemicals (such as PCB's). The case for continuing eligibility for projects to control and treat stormwater concentrates on the pollutant loadings contributed by this source.

The case for excluding projects for the control and treatment of stormwater rests on four arguments. First, based on the "Needs" Survey estimate of $235 billion, Federal support of the category would exhaust all available Federal funds many times over. Since there is no evidence to suggest that control and treatment of stormwater, even if technically and economically feasible, is more effective than investment in secondary treatment works, there is doubt whether such expenditures can be justified on the basis of cost-effectiveness. Second, the uncertainties surrounding the data relating to feasibility, effectiveness and cost of stormwater control and treatment are so great as to make the expectation of realizing benefits extremely pessimistic. Of course, this only means that stormwater eligibility should be reconsidered in the future when the uncertainties are reduced. Third, other EPA, state and local, and industrial pollution control programs may well reduce the need for treating stormwater. Fourth, since communities typically fund storm sewers -- a necessary component of a stormwater control system -- in the absence of Federal participation, Federal support of storm sewer contruction might replace local expenditures that would be made anyway. In this case, the overall beneficial impact of Federal expenditures would be reduced. In addition, Federal subsidies for storm sewer construction could induce otherwise uneconomical land development.

The uncertain cost-effectiveness of projects in this category, and the probable future change in the nature of stormwater pollutants require further comment. An EPA review of alternative waste management techniques flatly states that "Demonstrated technology to control storm sewer discharge does not exist."[1] That is, existing techniques have not been adequately tested to allow assessment of their individual or joint effectiveness in reducing pollutant loadings. Moreover, the effects on ambient quality of the pollutant mix usually found in storm runoff is unknown.

The cost uncertainties appear even greater. A recent report, which assumed that the unproven technologies would work, estimated a range of between $0.007 and $86.96 per pound of BOD removed.[2] This exceptionally wide variation necessitates a considerable analytical effort to obtain efficient results. In addition, because the relation between the stormwater pollutant mix and ambient quality is unknown, basic design problems have not been solved. For example, it is still unknown whether the capture and treatment of the first inch of surface water at the onset of a storm event is sufficient to protect water quality. Since costs vary enormously depending on the design criteria chosen, and the effectiveness is very uncertain, there is little reason to believe that program efficiency will increase by funding any stormwater treatment/control projects until these uncertainties are resolved.

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[1] Alternative Waste Management Techniques for Best Practicable Waste Treatment, EPA, March 1974.

[2] Investigation of the Components and Abatement of Total Urban Pollutant Loads. Enviro Control, Inc., 1973.

The need for treatment and control of stormwater may be diminished by other environmental efforts. For example, lead and mercury appear in stormwater because of the burning of leaded gasoline and fossil fuels, respectively. EPA efforts to reduce the use of leaded gasoline can be expected to markedly reduce, if not eliminate, the lead in stormwater. Emerging EPA and industry efforts to reduce air pollution could significantly reduce mercury loadings. In addition, BOD, COD, phosphates, and nitrogen loadings are expected to decline with the implementation of EPA's industrial pretreatment program, and the removal, by municipalities, of illegal sewer connections. While it is too early to claim that these programs will eliminate stormwater as a significant source of pollution, it does appear prudent to monitor these efforts before committing billions of construction grant monies to a high-risk program for stormwater control and treatment.

Combined Sewer Overflows:

The pollutant mix of combined sewers contains residential and industrial wastes, together with those typically contained in storm sewer pollutants. Emerging air pollution and industrial pretreatment standards are expected to decrease heavy metal and industrial waste loading significantly. However, residential waste will continue to be a large proportion of the pollutant content of combined sewer overflows.

Combined sewer overflows can account for a large proportion of total urban pollutant loadings. For example, a 1971 study of combined sewer pollution in the South River Basin, City of Atlanta, Georgia, found that combined sewer overflows contributed 24% of the total annual BOD loadings.1/

The case for continued Federal eligibility for projects to control combined sewer overflows is that, properly implemented, they can be extremely cost-effective, and local governments, since they spend little for these projects, are not likely to reduce their expenditures in response to Federal participation.

The potential cost-effectiveness of projects to control combined sewer overflows is well documented. However, the attainment of potential cost savings involves a considerable amount of data collection and cost analysis. Data collection is usually necessary to establish reasonable estimates of pollutant mix and loading. Cost analysis is complicated by the wide range of feasible options for controlling combined sewer overflows and the corresponding wide range of control costs. Control options include sewer separation, secondary treatment of overflow, regular sewer cleaning, repair of regulators, and the capture and controlled release of overflows. Estimated control costs for 1971 in Atlanta, for example, ranged from $0.0057 to $1.82 per pound of BOD removed, depending on the control option and degree of control selected. About the only generalization that has been drawn from numerous case studies is that the separation of combined sewers is inefficient.

Direct evidence of the magnitude of independent local efforts to control combined sewer overflows is nonexistent. Indirect evidence indicates that local governments have independently exerted little, if any, effort to address the problem. A survey of 641 jurisdications by the American Public Works Survey found that 96% experienced dry weather overflows. Of these, fully

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1/ Storm and Combined Sewer Pollution Sources and Abatement, EPA, Atlanta, Georgia, January, 1971.

one-half were reportedly due to improper regulator operation as opposed to inadequate capacity. The report on the Hudson River Conference area found that in six of the ten systems inspected, over 25% of the flow regulators were inoperative. The severity "... ranged from the need for adjustments to complete overhaul."1/ Atlanta chose not to modify regulators to eliminate interception of storm flows despite the fact that this would only cost $50,000 and effect a twenty-five percent reduction in annual pollution from combined sewer areas. 2/ This is not to indict Atlanta, but rather to indicate the level of local effort.

The efficiency arguments for limiting eligibility for projects to control combined sewer overflows are that (1) potential savings will often not be realized because of the more than usual difficulty in achieving cost-effective projects, (2) at least half of the combined sewer overflow problem is due to inadequate local operation and maintenance and not to a lack of capital equipment, and (3) the problem itself is more localized to particular areas of the country than it is national. Eighty percent ($24.955 billion) of the 1974 Needs Survey estimate of the total cost of correcting combined sewer overflow occurs in only ten states (these ten states account for 58% of 1974 non-stormwater needs). Thirteen states have not identified any requirements at all.

While projects to control combined sewer overflows can provide low-cost abatement that would probably not occur in the absence of a Federal program, these projects should receive special scrutiny because of the difficulty in achieving potential savings. Moreover, the dollar amount shown in the 1974 Needs Survey is significant ($31 billion). The means of achieving improved efficiency might include the designation of specially-trained teams to review grant applications and a separate annual authorization.

While this project category should remain eligible, several options are possible. One option would be to set up a separate authorization and allotment process. Another would be a reduced grant percentage. In the case of the first option, such an authorization would be intended to be exclusively for such projects. In order to achieve efficiency, the allocation would need to be based entirely on the documented, relative cost-effectiveness of all applications within the project category, i.e., within the separate authorization. Ideally, each application would be compared with all others nationwide, and the most cost-effective funded first. This allocation process would provide a direct incentive for communities to investigate thoroughly their alternatives and to propose efficient projects.

However, perhaps a more administratively attractive option would be to provide a reduced grant rate for this project category. Except where combined sewer overflow projects were highly cost-effective, there would be less incentive for communities to propose such projects.

1/ Combined Sewer Overflow Study for the Hudson River Conference, EPA, January 1973.

2/ op. cit., Atlanta, p. 2.

New Collector Sewers

There is a general case for discouraging collector sewer eligibility, particularly at a grant percentage as high as 75%. The fundamental argument is that such Federal expenditures displace local expenditures which would have been made in the absence of a Federal program. These Federal expenditures constitute an income transfer to communities that reduce the program's ability to undertake other beneficial projects. Moreover, because collector sewers are often a prerequisite to land development, such expenditures may encourage otherwise uneconomic development.

Approximately 76 percent of the U.S. population was sewered in 1973. Census Series E projections suggest that the growth in population sewered will range between 46.1 and 58.4 million, depending on whether 85% or 90% of the total population is sewered by 1990. These estimates indicate that the required annual growth in population sewered will average between 2.56 and 3.24 million persons per year through 1990.

State and local governments have demonstrated their willingness and ability to provide for annual increases of this size. Between 1948 and 1973, state and local governments provided, on average, sewer service for an additional 3.46 million persons per year. Very few collector sewer projects received significant Federal assistance during this period. Not only does the historical rate exceed projected growth in collector needs, but the rate of growth in population sewered appears to be increasing. Table 3 shows that the annual average growth in population sewered has increased from 2.78 million during the period 1948 to 1957 to 4.6 million during 1968-1973. Consequently, by and large, it appears that not only are communities willing and able to fund these projects themselves, but also that the future local burden will decrease over time.

Table 3: Annual Growth of Population Sewered

Period	Average Annual Growth In Population Sewered (Million)
1948-1956	2.78
1957-1961	4.00
1962-1967	3.67
1968-1972	4.60
1973-1990	2.56-3.24

This aggregate analysis might appear to ignore the funding problem that occasionally occurs with smaller communities, which are not now willing (or, perhaps, not able) to construct adequate collector systems. These communities are primarily rural and are, in some cases, facing public health threats. While the plight of these communities is serious enough, their unfortunate circumstances are not grounds for continuing across-the-board collector eligibility at the 75% grant rate: First, it is extremely difficult to restrict collector eligibility to poor communities experiencing public health threats. The major demands (as expressed in the Needs Survey) for new collectors come from urban and suburban areas that would build these facilities anyway, not from the poor areas. Second, both the Departments of Agriculture and Housing and Urban Development are actively involved in providing sewer and water assistance to needy communities. Together, these Departments are expected to obligate $767 million in 1975 for the provision of basic sewer and water facilities.[1] Agriculture is expected to obligate $550 million in 1976. Housing and Urban Development has not yet released estimates of 1976 obligations for basic water and sewer facilities because this program has been replaced by block grants. These obligations should be sufficient to address the most pressing collector needs.

According to the 1974 Needs Survey, communities will require as much as $17.5 billion (1973 dollars) to satisfy collector sewer requirements through 1990. Although this estimate may be overstated, any serious attempt to Federally fund a collector program of this magnitude would severely limit Federal funding for treatment installations.

In addition to the above, Federal funding may encourage uneconomic land development. This phenomenon is discussed further below, in reference to interceptor projects.

Notwithstanding the above points, there may be instances where new collector sewer eligibility is cost-effective. However, in order to reflect its cost-effectiveness relative to other project categories, a significantly lower grant rate should be considered.

Major Collector Sewer Rehabilitation

This category includes the replacement and major rehabilitation of existing collector sewers. Estimated state needs are $7.3 billion.

The rationale for discouraging eligibility for collector replacement at the 75% grant rate is very similar to that for eliminating new collector eligibility, but with one additional argument. The timing of sewer replacement depends on the level of maintenance they receive: well-maintained sewers last longer. Since communities bear the full cost of sewer maintenance, but can receive 75 percent Federal cost sharing for replacement, rather than to maintain existing sewers properly, it may be cheaper for them to neglect maintenance of older sewers in anticipation of Federal aid for a replacement. This can result in the premature scrappage of otherwise serviceable collectors and an increased overall cost for providing sewer service.

The solution for dealing with major sewer rehibilitation should be the same as for new collector sewers. If eligibility is to be retained, a significantly lower grant rate should be considered.

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[1] Source: Appendix to the Budget of the United States Government, Fiscal Year 1976, pages 167, 178 and 495.

Interceptor Sewers

There has been considerable controversy surrounding (non-regional) interceptor sewer eligibility. Arguments for continuing eligibility stress two themes. The first is that excluding interceptor eligibility would discourage cost-effective regional treatment. While participating communities, and the nation as a whole, might enjoy substantial savings from regionalization, the exclusion of interceptor sewers might make the local cost of such regionalization higher than that for individual treatment. Consequently, communities might opt for higher total cost (to the nation) individual treatment because the local costs they face are lower.

The second argument is that interceptors are an integral and costly part of any waste treatment project. Elimination of interceptor eligibility is, therefore, said to effectively lower the Federal share of waste treatment cost and increase the local financial burden.

There are four efficiency arguments for restricting interceptor eligibility. The first is that, if care is not exercised, continued interceptor eligibility, rather than encouraging appropriate cost-saving regional planning programs, may discourage the formation of those regional management authorities requisite to improved efficiency. That is, since Federal support of non-regional interceptor projects reduces the local cost of inefficient community behavior, local governments are encouraged to retain local autonomy in the provision of waste collection and treatment services.

The second argument is that local governments are often apparently willing and able to fund interceptor projects by themselves. Since treatment presupposes some interceptor system, and since Federal support of interceptors (until PL 92-500) had been minimal over the preceding 26 years, both the increase in population treated and changes in the ratio of treated population to sewered population during that period are useful proxies for local willingness to fund interceptor projects. (These proxies underestimate the growth of interceptor capacity because (1) they do not account for excess capacity and (2) some interceptors do not connect to waste treatment plants.) Between 1948 and 1973, treatment increased from 62% to 97% of population sewered. The annual growth in population treated averaged 4.6 million persons over the period. Since interceptor requirements, as derived from Census population projections, indicate growth in population sewered of less than 4 million per year through 1990, there is some evidence that local governments have been willing to provide sufficient interceptor capacity on their own.

Table 4: Growth in Population Treated

	Average Annual Increase (Million)	% of Treated Population to Sewered Population
1948-1956	3.2	76
1957-1961	5.4	86
1962-1967	4.6	92
1968-1973	5.0	97

The third argument for excluding interceptor eligibility simply notes that interceptors, per se, do nothing to increase water quality. The relevant issue is whether obligation of limited Federal funds to municipal systems which only lack adequate treatment is more cost-effective than similar obligations to systems which lack both adequate treatment and interceptors. Strictly speaking, this is an argument for eliminating interceptor sewer eligibility only if Federal funds for treatment facilities are exhausted before interceptor projects become cost-effective.

The fourth argument is that, even if interceptor projects are deemed cost-effective, potential efficiencies are difficult to obtain. There is little doubt that a large proportion of the capital cost of some interceptor projects has resulted in excessive capacity. Communities perceive local spillover benefits, such as increased development, windfall profits for local developers and land owners, and an increased tax base, from interceptor projects. Since the local capital cost share is only 25%, and can, depending on state participation, be reduced to zero, the community has every incentive to maximize such spillover benefits. This can be done by basing grant applications on overly-optimistic population and industrial growth projections, ignoring the longer-term environmental and land use impacts of promoting growth, and insisting on inefficient (i. e., non-regionally based) interceptor routing.

To eliminate the potential for misuse, the EPA Regional Offices and the States must carefully review interceptor project applications. The recent increase in manpower to the EPA Regions may aid in the analysis. For several reasons, it is infeasible to suggest that interceptors be made ineligible for grants at this time. Considering the history of Federal grant eligibilities, the wastewater treatment planning that has taken place on the basis of interceptor eligibility, and the fact that interceptors are considered an integral part of waste treatment, it would be very disruptive to the Construction Grant Program if such projects were declared ineligible. Moreover, interceptor eligibility provides some "handles" for the Federal government to oversee the management of waste treatment by communities.

As documented in a recent CEQ report,1/ interceptors can open up large land areas for low density residential and industrial development. Even if local treatment facilities are achieving high removal efficiencies, the interceptor-induced growth of residential and industrial wastewater can be sufficient to more than offset the high removal rates and result in a net increase in effluent pollutant loadings. This is exclusive of the additional pollutant loadings contributed by urban runoff and the nonpoint pollutants associated with new housing, business and industrial construction. Such findings point out the necessity for regional planning, including the ability to promote regional interceptors in a manner consistent with environmental goals.

Conclusion

This subsection has considered the pros and cons of increasing program efficiency by restructuring eligibilities. For example, based on a 75% grant rate, and using data from the 1974 Needs Survey, removal of Federal eligibilities for major sewer rehabilitation, collector sewers, and storm sewers could reduce the potential Federal commitment from $257 billion (75% of $342 billion) to $62 billion (in 1973 dollars).

Some savings of Federal resources could be expected to come about primarily from shifting Federal funds to project categories that local governments would not, of their own volition, adequately support. The shifting of responsibility for collector project categories to local governments is not expected to slow attainment of water quality goals because localities have done a good job of supporting collector projects and other governmental programs are available for aiding the poorer communities. The expected future project Needs for collectors are well below historical accomplishments.

b. Eligible Costs and Capital Bias

The construction grant program restricts Federal cost sharing to eligible cost components. Most cost component restrictions are innocuous. However, the exclusion of Federal eligibility for operation and maintenance has generated considerable controversy. Critics have made two assertions.

The first is that, because capital costs are subsidized by the Federal government, while O&M costs are not, communities design overly capital-intensive projects in order to reduce their share of projects' life cycle (capital plus O&M) costs. To the extent that this is true, the number of projects that can be supported with Federal funds is reduced.

The second assertion is that without Federal and/or state support, communities will continue to provide inadequate O&M. This section discusses these issues and indicates the options that are available for dealing with them.

1/ Interceptor Sewers and Suburban Sprawl, CEQ, 1975.

Capital Intensity/Bias

A characteristic of any subsidy program which provides only a construction or capital grant is that an incentive is created for each grant recipient to choose ways of achieving a desired output that requires a greater intensity of capital investment than would be chosen in the absence of a subsidy. This program characteristic is commonly described as a capital bias and exists simply because the construction grant changes the relative price to the community of capital in comparison to operating resources. The concept of capital bias, or excess capital intensity, does not refer to excessive capacity in a facility, but rather to excessive automation. Of course, the existence of a capital bias reduces the number of projects which can be supported with federal funds.

Many critics of the current program believe that the most significant program characteristic that creates a capital bias (and underperformance) is the lack of an operating incentive for a facility's on-going operation and maintenance (O&M). In other words, the subsidy currently received by a municipality for its role in the wastewater abatement effort is a percentage of the total construction costs needed to design and build the treatment facility. Of course, whenever a community can choose between a larger capital expenditure in the construction phase or higher operating costs in the future, the tradeoff from the community's viewpoint almost always favors the capital investment. The greater the capital grant percentage, the greater this bias will be. Essentially, the community's objective is to choose a treatment alternative that achieves federal standards but at least cost to itself. Clearly, the least cost local solution may not be the least costly alternative to the nation.

Another program characteristic directly related to the capital bias issue is the size of the grant rate. A 75 percent Federal cost share is sometimes held to be so large that a municipal government is not likely to be especially conscious of investment alternatives. This problem is further aggravated in those states where additional state grants are available to supplement the Federal payment.

There have, until recently, been institutional factors in the existing grant program arrangements that promote a capital bias. For example, it was customary practice to base architects'/engineers' fees for design of a facility on the amount of capital costs. This practice gave them an incentive to design capital-intensive facilities. This is no longer allowed. Fixed fees (or similar arrangments) are now used.

The municipality's relative ability to fund the different kinds of costs comprising its share of pollution abatement may also cause a bias at the local level. Municipalities may find it easier to allocate funds to capital costs than to current operations. When funds are short and expenditures must be cut, servicing the debt issue normally takes precedence over current maintenance and operating requirements. Hence, a municipality may be better able to sustain funding of capital-intensive techniques than non capital-intensive techniques, and may, therefore, tend to have its abatement activities biased towards capital-intensive techniques, apart from any Federally-induced bias.

Though the rationale to support the hypothesis of a capital bias is strong, empirical research conducted to date has not conclusively demonstrated that such a bias does in fact exist. Morever, it is possible to construct specific examples in individual areas which show that, under some conditions, the least cost municipal project would be one with a greater total capital investment than equally effective less capital-intensive alternatives. Some empirical evidence of a financial bias has been developed by estimating a capital-labor production function for a sample of 23 activated sludge plants in Connecticut. The estimated function shows a negative marginal productivity of capital -- a result which indicates that improvement in treatment efficiency could be obtained by substituting O&M dollars for capital dollars. However, the design and statistical reliability of the results are questionable.

An interesting, though curious result has been noted during an EPA examination of nine grant submissions. The examination indicated that communities do not appear able to effectively substitute capital for O&M. In this study, each grant proposal was compared with a more cost-effective project that performed the same function as the initial project. The comparision indicated that more cost-effective designs could have resulted in both capital and O&M savings. Capital savings of up to 68% and O&M savings of up to 50% could have been achieved. Thus, these communities did not seem especially good at minimizing their own costs. Furthermore, in 4 of the 9 cases, the percentage O&M savings exceeded the percentage capital savings -- a fact not consistent with a capital bias hypothesis.

One concern with the lack of an O&M-type subsidy can be raised regarding the program's equity: Different communities will receive grants (subsidies) representing differing proportions of total costs. Total costs are the sum of initial land and capital costs plus operating and maintenance costs over the life of the project. Since the grant subsidy is a fixed percentage of capital costs, it is evident that if two communities with equal capital investments have different operating and maintenance costs, they will in essence receive different subsidy rates in terms of their total costs.

Based on the foregoing, it should be apparent that an incentive for a capital bias does exist, and, as communities become more aware of the opportunities for reducing the local costs of compliance, capital bias may well become a documented, serious problem.

Within the program's confines, there are two basic options to reduce or eliminate the incentive for capital bias. They are:

1. Reduce the grant rate.
2. Base grants on cost criteria besides capital costs alone.

Variants of the second option include basing the grant on (a) total (life cycle) project costs, (b) the lesser of a percentage of construction costs or total project costs, and (c) block grants.

The first option is simply to reduce the construction grant rate. For example, the rate might be lowered from 75 to 50 percent. It is sometimes suggested that this change, by diminishing the distortion between the relative prices that a community must pay for capital equipment and operating resources, would tend to result in a more efficient initial project design. In other words, the lower grant rate would raise the price of capital equipment to a community and thereby presumably mitigate the tendency to design an overly capital-intensive facility.

There are several arguments against lowering the grant rate. First, a lower grant rate could discourage communities from building facilities, either because they cannot afford them or do not rank their importance sufficiently high to wish to undertake such projects. In the latter instance, the community would have an incentive to delay compliance by initiating court suits. Although the grant rate was less than 75 percent prior to PL 92-500 and no funds went unused, this is not necessarily evidence that communities would be willing to provide treatment at a lower grant rate. The reason is that, prior to PL 92-500, community treatment was directed toward disease prevention, i.e., to reducing immediate threats to public health. The Act is directed toward the much more costly objective of minimizing long term threats to human and aquatic life. The additional cost of complying with the higher treatment standard could encourage communites to delay compliance. Litigation concerning both the equity of reducing the grant rate and the community's ability to finance the mandated treatment could effectively delay water cleanup goals pending court resolution.

A second argument against reducing the grant rate is that the 75 percent grant rate was set because of equity considerations, and to lower it would be unfair to poorer communities. This point is strengthened by noting that over its lifetime facility construction is only 25%-50% of the total cost burden that a community must bear to treat its effluent. Since subsidies are not given for operation or maintenance, reducing the grant rate would transfer a higher percentage of total treatment (as well as construction) costs to communities. Moreover, the grant rate should not be considered apart from the issue of project eligibilities. If eligibilities are narrowed to project categories that are most cost-effective, a stronger case for retention of the current rate can be made. Another possibility would be to vary the grant rate by treatment project category. Of course, reducing the grant from 75 to (say) 50 percent would only reduce, but not eliminate, the incentive for capital-intensive facilities. In fact, the only way to eliminate this incentive completely is to eliminate capital grants entirely.

Third, a community's incentive to construct treatment plants is often relatively low because the primary beneficiary is usually not the community itself but, instead, downstream communities. A community has traditionally had more incentive to build collection and interceptor sewers, since the beneficiaries reside in the community. A reduction of the grant share would reduce incentives to construct needed (treatment) facilities.

The second option to reduce the capital bias is to base the grant on factors other than just capital costs. The idea is that if communities cannot reduce local costs by overinvesting in capital or land, they will be more likely to design economically-efficient facilities.

One variant of this option is to calculate the grant as a percentage of total project costs (capital and O&M) rather than simply as a percentage of construction costs. This option would eliminate the existing economic incentive to trade off O&M costs over the life of the project in favor of initial capital expenditures. Furthermore, this program change would eliminate the unequal treatment of municipalities which spend equivalent amounts on initial plant construction but anticipate unequal operating expenses because of variant system conditions.

However, because of the higher total costs per facility, a characteristic of this option is that if the same number of projects were to be funded in a given year as under the current program, either the grant rate would have to be reduced or more Federal funds expended. For example, with Federal obligations limited to $4 billion per year, and grant-eligible O&M costs of $4 billion, the effective grant rate would fall to 43 percent (Table 5).

Table 5: Implied Grant Rates (Percent of Total Project Cost)
With Addition of O&M to Current Program

Grant Eligible O&M Costs	Obligations		
	$2 billion /year	$4 billion/year	$6 billion/year
$2 billion/year	43%	55%	60%
$4 billion/year	30%	43%	50%
$6 billion/year	23%	35%	41%

Table 5 shows, for obligations of $2 billion, $4 billion, or $6 billion per year, the effect on the grant rate of the introduction of an O&M subsidy. That is, for a given level of obligations, each figure (%) displayed represents the percent of total project costs that would result from different mixes of capital and O&M subsidized costs. The table assumes that the same number of projects would be built after the initiation of an O&M subsidy as before the subsidy. 1/ The first column in Table 5, entitled "Grant Eligible O&M Costs", assumes fairly substantial amounts for eligible O&M costs. This is because O&M eligibilities would apply to all existing plants, not just to those receiving a capital grant.

A major problem associated with this option (if based on cost criteria) is that subsidizing costs (instead of abatement) may not be cost-effective. In practice, it is difficult to do, and there is no accurate enough method for estimating future O&M costs. Over groups of plants, O&M costs can be estimated for planning purposes, but individual plant conditions have been too variant to estimate O&M costs with enough precision to set up a grant program for this cost category. As a consequence, if such a program were instituted, each applicant for a grant would presumably attempt to "bargain" as large an operating allowance as possible. This bargaining process would certainly add to the program's administrative costs and might eventually create further allocative distortions. Even if EPA headquarters issued a set of guidelines (formulas) for determining the O&M costs, there is no way to avoid inequities created from possible errors in estimation. Of course, if reimbursement for O&M expenditures were to be proposed based on actual, experienced (rather than estimated future) costs, there would be no assurance of efficient performance (and every incentive to overspend for O&M). As discussed in the next section, even if an O&M subsidy were proposed based upon performance criteria, one would have to demonstrate that funds used to subsidize O&M were more cost-effective than the same funds used to construct additional capital facilities.

Another variant of the second option is to calculate the grant amount as the lesser of (a) a percentage of total construction costs or (b) a percentage of total project costs. The concept involved here is that if a project were designed to meet the standards at least social cost, it would also be the least costly project to the grantee.

1/ For example, with grant-eligible capital costs of $2.67 billion (75% of which is $2 billion) and eligible O&M costs of $2 billion, total eligible costs are $4.67 billion. However, with a limitation on funds (annual obligation) of $2 billion, the effective grant rate falls to $2 billion/$4.67 billion, or 43%. Note that this percent is the first entry in Table 5 above.

For example, for some projects, the current 75 percent capital grant is equivalent to between 25 and 50 percent of total project costs.[1] This option would stipulate a grant equal to the lesser of 75 percent of construction costs or 25 percent of total project costs. Unfortunately, most of the same problems already discussed above would also be true of this alternative.

The final approach is to replace cost sharing with block grants. The block grant would consist of a lump sum Federal grant to the States. EPA's role would probably be reduced to allotment of funds, issuing criteria for eligibility, and reviewing State priority lists to assure that potentially approvable projects meet eligibility requirements. The States would probably be given full responsibility for managing the construction grants program within their jurisdictions and would be given broad discretion over the use of Federal funds within the eligibility requirements established at the Federal level. Annual allotments would be made to the States, with a portion earmarked to cover administrative costs.

By taking the major project-related responsibilities away from the Federal Government, the block grant approach could weaken the overall effectiveness of the program. Each State would adopt its own criteria for project approval. Politics would be more likely to influence project selection than with a federally controlled and directed system. The opportunities for fraud or misuse of funds might be increased.

All of the inefficiency and equity arguments already noted (except the capital bias argument) with respect to the current program would continue, with no assurance of an impartial overview to ensure proper use of funds. Because local preferences for system components, such as collectors and interceptors, are not necessarily consistent with the national goal of efficient and equitable cleanup of the nation's waterways, the attainment of water quality standards would be slowed and thus more costly than under the limited-eligibility Federal program described above.

Facility Performance

Operation and maintenance (O&M) was discussed in the previous section in relation to the problem of capital bias. The issue of Federal support for O&M arises as well in terms of ensuring adequate facility performance, regardless of the existence or extent of capital bias.

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[1] Under the assumptions that annual operating costs, on average, represent between 7 and 12 percent of treatment plant replacement values, that a plant life is 20 to 50 years, and that the appropriate discount rate is 7 percent. Contractor studies have suggested these factors have been approximately correct in the past.

The granting of the entire subsidy payment for construction costs may not provide incentives for efficient facility performance. This may be less attributable to the magnitude of capital subsidy than to the lack of incentive provided for efficient future facility performance itself. Even though it would seem that, having been heavily subsidized for the needed investment, a community would be willing to provide proper maintenance and operating expenses to achieve clean water, experience indicates that, unfortunately, already existing facilities are in many cases operating significantly below design specifications. In this connection, numerous govenment and private surveys have documented the extent and nature of inadequate O&M in municipal systems. EPA's Clean Water Report to Congress - 1974 states that, of the operating plants inspected during the past year as part of the routine construction grant follow-up, 30 percent of those plants with sufficient data for analysis were not achieving designed effluent quality. 1/ An American Public Works Association survey 2/ of 641 combined sewer jurisdictions found that 48% experience dry weather overflows because of inadequate operation and maintenance. Finally, a significant proportion of the estimated $12.4 billion cost of major sewer rehabilitation and the correction of infiltration and inflow appears to be due to previously inadequate local O&M efforts.

Perhaps the two most obvious options available to address the performance problem are:

o Conditional Grant Awards (based on performance), and
o O&M Subsidies

The Act requires (Section 204(b)(1)) that no grant will be approved unless the grantee "... has (the) legal, institutional, managerial, and financial capability to insure adequate construction, operation, and maintenance of treatment works...." The Act does not require grantees to demonstrate their willingness to support adequate O&M.

One approach to encouraging better O&M in new facilities is to make grant awards conditional on facility performance. Specific policies might include:

1. Contractual agreements between the EPA and the grantee,
2. Requiring grantees to post performance bonds,
3. Administrative requirements which ensure that rudimentary procedures are to be implemented.

1/ Taken from: Review of the Municipal Waste Water Treatment Works Program, EPA, Nov. 1974, page 16.

2/ Combined Sewer Overflow Study for the Hudson River Conference, EPA, Jan. 1973, page 26.

Contractual agreements would have to specify the meaning of "adequate O&M," i.e., whether in terms of acts performed or of system performance, and penalties for default and procedures for adjudicating disputes would need to be spelled out. Though such formal contractual agreements do not currently exist between EPA and grantees, both municipal permits and routine "grant conditions" contain similar specifications. Hence, there is some question as to whether a contractual agreement would provide much improvement. However, even if one can make a case for formal contract agreement being effective for new facilities, they would not affect existing facilities. In addition, if a new facility is part of an older system, it is not clear that EPA could successfully insist upon systemwide O&M standards. Finally, the adjudication of disputes could prove expensive and time consuming.

Performance bonds share many of the features of a contractual agreement. However, they have the potential drawback of requiring communities to raise additional funds prior to receiving grant money. Even to the extent that communities are willing but unable to fund wastewater treatment projects, the increased financing requirement would reduce cooperative community participation.

As mentioned above, the Act requires the Administrator to take care that grantees provide adequate O&M. This has led to development of operation manuals, contractor training of key personnel and EPA training programs. These conditions only apply to facilities which are built under the 1972 Law. It is too early to determine the impact of these actions. However, they are likely to be successful only to the extent that inadequate operator knowledge accounts for less-than-efficient design performance.

Another approach to achieving more effective performance is by a Federal and/or state O&M subsidy. Such a subsidy can be based either on estimated municipal O&M expenditures per se (this option has been discussed in the previous section) or upon system performance as measured by pollutant removal to some level of abatement. The latter is called an output subsidy, and, if carried to its conceptual limit, becomes the "subsidy-equivalent" of an effluent charge system. The output subsidy is paid for achieving removal efficiences above some specified level, and can either be restricted to new facilities or be available to all treatment works.

O&M subsidy programs in general have the disadvantage of tending to provide a large, indefinite commitment of Federal (state) funds. Furthermore, economic efficiency is better served if O&M costs are "internalized" through user charges. Though tradeoffs between O&M and capital do exist, in-depth analyses of these tradeoffs have not been performed. The initiation of an O&M subsidy does, in fact, assume that monies spent for O&M are more cost-effective than the same funds would be if used to subsidize additional capital expenditures. Preliminary study, suggests that, with O&M costs subsidized at a 25% rate, annual program costs would be in the range of $300 million (1973 dollars) for waste treatment plants. Estimates of the cost of an output subsidy were not made for this study.1/

1/ Some "first cut" efforts to study the problem and make such estimates are provided in Economic Analysis of Selected Features of Municipal Wastewater Treatment Legislation, M. Rose and J. Goldstein, forthcoming.

One difficulty with an output subsidy is that, when capital expenditures for increasing removal efficiency are cost-shared and capital can be substituted for other factors (labor, land, energy, etc.), the subsidy, if effective in improving removal rates, provides a local incentive for excessively capital-intensive facilities. The rationale for overcapitalization is identical to the rationale already discussed above for a capital bias in providing for system capacity by means of a capital grant. Consequently, if, in the absence of an output subsidy, an overcapitalization bias exists, the output subsidy could evoke an even larger bias in this direction. Hence, in combination with capital grants, a performance subsidy is an inefficient means of improving system operation. 1/ In addition, there are practical problems. For example, the level of the appropriate output subsidy would have to be high enough to evoke satisfactory O&M but low enough to preclude an additional incentive for capital bias. It is not clear that such a subsidy rate can be identified without a good deal of trial and error. Moreover, since O&M costs vary widely by community, the appropriate subsidy rate might, in order to promote efficiency and to avoid capital bias, have to be determined on a case-by-case basis. Though there are economic advantages to an output subsidy program (not here enumerated), the concept is such a drastic departure from past grant practices that it is unlikely that substantial support could be generated for such a program.

A case can be made that available evidence also casts doubt on whether O&M type subsidies are particularly effective in increasing water quality. The state of New York currently has a program which provides a one-third O&M subsidy to those plants satisfying criteria related to cost-effective operations. This program has operated since 1965 and has disbursed $72 million through 1973. The results appear mixed. There is no direct statistical evidence of "...general improvement in flow reduction, suspended solids removal, or BOD removals..." 2/ However, there is some evidence of improved operator training and of less rapid facility deterioration. It must be admitted, however, that despite the lack of empirical verification, a number of researchers and operational personnel are of the opinion that a positive relationship exists between an O&M subsidy and pollution abatement.

A mechanism for encouraging better performance is already provided by the National Pollution Discharge Elimination System (NPDES), which requires that all municipal and industrial "point source" dischargers obtain pollution permits from the EPA. These permits, which contain a requirement for adequate facility performance, specify pollutant loadings, and their violation can lead to civil suits and criminal prosecution. The Permit System tends to provide the case-by-case orientation necessary to ensure adequate facility performance.

The monitoring program is still new. Before costly alternatives are implemented, the NPDES should be given a chance to operate. Certainly the monitoring and administrative infrastructure necessary for an effective regulatory program is present. Only if this program proves ineffective should the higher cost subsidy options be seriously entertained.

1/ Since a performance subsidy does not itself (i.e., apart from a capital grants program) necessarily imply a capital bias, such subsidies are more properly viewed as an alternative to capital grants.

2/ New York State Aid for Operations and Maintenance of Sewage Treatment Plants: Implications for Federal Policy, META Systems, pg. 1.

3. Excessive Capacity

In addition to the issue of capital bias, questions may arise concerning the possibility of a bias toward building systems with excessive capacity. The term excessive capacity is used here to mean overly large, rather than capital-intensive facilities. In the first instance, the EPA specifies the planning period within which a specific community may determine an appropriate design period, i.e., the expected time interval between expansions of a pollution abatement project. Initial facility capacity is determined by multiplying the design policy by the average annual growth in waste treatment demand. Annual growth in demand is usually considered to be proportional to population growth.

It is necessary to construct any new treatment facility with initial capacity in excess of the level needed to serve the present population in order to handle wastewater from population increases occurring in the service area.

Of course, any excess capacity initially installed represents investment resources that could, in principle, be used in another community to deal with a current treatment problem. The problem is, therefore, to balance the current incremental capital costs incurred to provide excess capacity against the longer term benefits (such as future capital savings) resulting from providing the excess capacity. The incremental cost of excess capacity is a dollar measure of other projects that are foregone because of the decision to provide excess capacity.

When population grows at a constant (arithmetic or geometric) rate, the least cost design period for waste treatment plants and interceptors depends on the discount rate applied to future expenditures and on the economies of scale occurring in each facility category. Economies of scale, which are large in waste treatment plants and interceptors, occur when proportionate increases in facility capacity lead to less than proportional increases in cost. If all costs, regardless of when incurred, were weighted equally, existing economies of scale would make it economical to size interceptors and waste treatment plants for the "ultimate" population, i.e., to make the design period as long as the planning horizon. However, in the presence of discounting, future costs are weighted less than current costs. Consequently, by shifting the timing of these expenditures from the present to the future, (discounted) costs are lowered. This results in the adoption of a design period which is shorter than the planning horizon. Instead of initially building one large facility, several smaller facilities are phased in as existing treatment plants and interceptors reach capacity utilization.

The least cost design period depends on a complex comparison of the magnitudes of the economies of scale and the discount rate. Reduction of the design period decreases initial facility cost, but, because the economies of scale are not fully exploited, increases the undiscounted cost of meeting capacity requirements. The discount rate is, therefore, crucial in determining whether the initial savings are sufficient to offset the increase in the nominal cost of providing capacity. As might be expected, the higher the discount rate, the shorter is the least cost design period. Likewise, the larger the economies of scale, the longer is the least cost design period. With large economies of scale, this is (at least partially) because large reductions in the design period result in very small savings on the initial facility.

Before P.L. 92-500, the tendency with regard to reserve capacity was to follow "rules of thumb" -- a 20-year design period for treatment plants and a 50-year period for interceptors. EPA analysis has subsequently shown that, given the relatively low interest rates prevailing at the time, the 20/50 policy was not unreasonable. The Act emphasized "cost-effective" design periods, and in the interval since 1972 this has become a requirement. In fact, EPA analysis (see Appendix C) now indicates that, given current conditions, 20/50 design periods usually exceed the optimum. The range for cost-effective design periods vary considerably, however, from about 5-20 years for treatment plants to about 20-40 years for interceptors. Because of this variability, stipulation of specific design period limitations applicable to all facilities nationwide would be arbitrary. The analysis that was performed takes into account a number of considerations, such as the appropriate interest rate, plant economies of scale, expected growth rates, penalty costs associated with noncompliance, and so on. Sensitivity analysis performed on all of these variables indicates that only extreme assumptions would yield an optimal design period equal to or greater than the 20-50 criteria. However, cases can arise where a community can clearly demonstrate the cost-effectiveness of a longer design period.

Adoption of cost-effective design periods permit additional monies to be made available to fund more facilities and are consistent with limiting the Federal commitment, while simultaneously promoting program efficiency.

4. Industrial Cost Recovery

The 1972 Act stipulates that all recipients of waste treatment services must pay for their share of operation and maintenance costs through user charges. Moreover, industrial recipients of treatment services are required to pay for their portion of the Federal share of construction costs allocable to the treatment of industrial wastes. Industrial repayment of the Federal share of construction costs is known as cost recovery.

Industrial cost recoveries are to be paid over 30 years, or over the life of the treatment plant, whichever is shorter. The 1972 Act does not require that an interest charge be included in the cost recovery of the Federal share.

Though this interest-free "industrial loan" must be repaid, the municipal grantee is allowed to retain one-half of the amount allocable to the Federal grant that is recovered from industry. Of this retained amount, 20 percent is discretionary and thus can be used by the grantee as it chooses; 80 percent must be placed in a reserve fund, the principal and interest earned thereon to be used to pay for the costs associated with the project necessary to satisfy the requirements of PL 92-500.

The reserve fund can be used only for eligible project costs related to expansion and reconstruction of the original project and only with written approval of the Regional Administrator. The holder of a reserve fund may apply that fund to project costs for which a grant is requested or may use them for project costs apart from any grant request. However, if a grant is forthcoming, the amount in the reserve fund must be deducted from eligible project costs for purpose of determining the size of the grant. Thus, whenever a grant is received, the reserve-fund-holder has no choice but to apply the amount then in the fund to that project, and have the amount of the grant thereby reduced; he need not, however, have held the fund until a grant was forthcoming.

The municipality is free to negotiate with industry to recover the local share of construction costs allocable to industry. The local share of construction costs allocable to residential users may be recovered from local residents by the grantee as well. Nevertheless, the 1972 Act does not require that the local share of construction costs be recovered or paid for in a designated manner. Accordingly, the method used to finance and recover the local share of construction costs is left to the discretion of the local community.

There are several reasons why users, including industrial users, should meet their share of the costs of sewerage treatment systems. First, users benefit from the treatment of their wastes and it is equitable that they pay for this service. A properly designed user charge system will enhance the equity characteristics (disregarding for the moment the regressive nature of user charges) by distributing costs in a manner more closely related to the service provided than will other ways of raising revenue. The revenues generated can be used to pay current operating costs and to provide funds for amortizing the debt instrument generally used to finance construction costs.

Second, effectively-administered user charges also improve the management of industrial wastes. Charges related to the cost of treating wastes, based at least on volume and strength, create an incentive for industrial users to pretreat, change processes, and manage their wastes more effectively.

Third, when the cost of the service is directly borne by all users (residential, commercial, or industrial), economic efficiency is promoted. The users have a vested interest in seeing that the treatment system is planned and managed to minimize costs, whether through a reduction in unnecessary excess capacity, substitution of operating costs for construction costs where they are lower, efficient plant operation, staging of construction where possible, or use of lower cost technologies, if applicable. User charges and cost recovery serve as "price signals" to recipients of treatment services. As such, the charges act as a mechanism for distributing the demand for wastewater treatment services to those activities and areas in which the demand can be satisfied at least (incremental) cost.

Effect of Cost-Recovery on Municipalities

The rationale for the policy permitting municipalities to retain one-half of the cost recovery is to provide the municipality with a source of funds whereby it might become self-supporting in abatement activities. However, because the retention of both the 20% discretionary and the 80% reserve funds lowers the effective local share of construction costs, cost recovery has important implications for the efficient allocation of abatement resources and for the relative burden of abatement costs borne by communities which differ in the mix of residential and industrial users.

It can be shown that the net effect of the reserve fund is to reduce the muncipality's cost share beyond the reduction rendered by the discretionary funds alone. This occurs because the amount accumulated in the reserve fund is applied to eligible construction costs without an equal reduction in the amount of grant received. For example, with $10 in the reserve fund and $100 in grant-eligible costs, the computation is: ($100-$10) = $90 x 75% = $67.5; but the total monies from the Federal government are $67.5 + $10 = $77.5, which is $2.5 greater than 75% of the original $100. The municipality's cost share is $22.5 rather than $25.

There appear to be other, more subtle effects of user fee arrangments on cost shares. For one thing, existing arrangements appear to provide incentives to spend the reserve fund on eligible costs of projects accorded high priority by the community but low priority in the grant approval process. (Likely examples of such projects are sewage collection-related projects, as opposed to more treatment-related projects.) By applying the reserve fund to costs of projects which it wishes to undertake, but for which it is unlikely to be successful in receiving a formal grant, the community can reduce the amount of costs it does expect to receive, and the community will avoid having the fund reduce the amount of the grant.

Another impact of the reserve fund is its possible effect on increasing the reserve-fund-holder's prospects of obtaining additional formal grants. Due to the possibility of bringing forth a relatively larger total project with a relatively smaller additional Federal grant, the grant office may accord higher priority to the grant application of an applicant having such a fund than applicants without a fund. This characteristic may provide conflicting incentives to that observed above, inasmuch as it may encourage the community to apply its fund to partial payment of major projects for which it is actively seeking grant assistance.

A further point is that with the existing arrangments there is no guarantee that the municipality will choose to use the discretionary fund for wastewater abatement. Hence, a portion of the Federal subsidy may not contribute to the grant program's objective of providing an incentive to municipalities to construct treatment works.

In any case, the retention of user fees appears in general to raise the effective Federal subsidy above 75% of construction costs and to reduce the municipality's share below 25% of construction costs. Part of the increased subsidy results from the discretionary portion of retained user fees and part is attributable to the reserve fund.

For a given treatment load, the retention of user fees also results in communities that have a higher level of industrial participation bearing a relatively lower share of the treatment costs. The share of construction costs to a residential community is equal to 25%, and the subsidy amounts to 75% of construction cost. But for an industrialized community, the subsidy amounts to 75% of total construction cost plus 25% to 100% of the (present) value of the reserve fund plus the present value of the discretionary fund, and, consequently, the local share of cost is less than 25%. Thus, for a given treatment load, the communities servicing industry are given an additional Federal contribution beyond the 75% of construction costs that residential communities do not receive. However, of more significance is the relationship between the percentage cost shares borne by communities and industrial participants in the municipal system and the percentage contribution of each to the total treatment load. Recent analysis 1/ indicates that, under the provisions of P.L. 92-500, a municipality's share of the cost is very insensitive to its contribution to the load. Over fairly wide ranges of assumptions regarding interest rates and plant lives, municipalities will have to pay in the neighborhood of 20% of the cost no matter how much or little treatment load they produce. Though the effect of high interest rates, high levels of industrial participation, shorter plant life, and the retention of monies (discussed above) do serve to reduce the community's share somewhat, the rate of decrease is slight.

Collins' analysis indicates that the picture changes considerably, however, with respect to industry's cost share. There is considerable deviation between industrial participants' cost shares and their percentage contribution to treatment load. This is discussed further in the next section.

1/ Water Pollution Abatement Financing Under P.L. 92-500; Who Pollutes, Who Pays? Dr. Robert A. Collins, Agricultural Journal Paper (Series No. 7387), Dept. of Agricultural Economics, University of Missouri-Columbia, September 15, 1975.

Effect of Cost Recovery on Industry

The absence of an interest charge i.e., not recovered in the user charges that are paid, on the industrial share of the grant enables any firm participating in a municipal system to receive a substantial indirect Federal subsidy. This occurs because the amount collected from industry is less than the amount of Federal funds spent in the public treatment system for industrial abatement facilities. Except to the extent that the intent of the Law was to provide cost-sharing assistance to industry as well as to the nonindustrial sectors of communities, interest charges are needed to compensate for the time preference of money. If industry provided its own abatement facilities, it would forego the use of the investment funds for other purposes. Similarly, substantial potential public revenue is foregone. Using an opportunity cost of capital of 10%, recovered over 30 years, and assuming that the industrial share of all local costs is recovered from industry, it can be demonstrated that the implicit subsidy to industry on the Federal share is 69%. If one takes into account that many states provide supplementary grants that also do not require that interest be recovered, and that (in the Federal program) the 25% local share of industrial costs need not be recovered at all, the effective subsidy to industry will, in many instances, exceed the 75% subsidy to municipalities. At the same time, industry can benefit from economies-of-scale in public treatment, from avoiding the costs of obtaining their own permits, and (as long as they meet certain pretreatment requirements) from avoidance of certain monitoring responsibilities. Firms participating in a municipal system also avoid the necessity to raise external capital themselves to purchase pollution control equipment, i.e., they do not have to go to the capital markets to borrow funds, thereby perhaps altering their debt-equity ratio.

As mentioned above, there is considerable disparity between industry's percentage cost shares and their percentage contribution of treatment load. For plant lives of 25-30 years, industry's cost share ranges from roughly 20% to 40% of the costs that are attributable to them, depending mostly on the interest rate and the plant life. The higher the interest rate and longer the plant life, the less their cost share is. The Federal government, of course, pays a disproportionate share. For example, for a system with 100% of the load contributed by industrial sources, a plant life of 25 years, and an interest rate of 12%, the industrial cost share is only about 24%. In this situation, the municipal share is about 20% and the Federal share is the balance (56%). Though for shorter plant lives (design periods), the industrial share increases, for a life of 10 years (other conditions remaining the same as above), industry's share is still only 44% -- yet in this example they are contributing 100% of the load. This raises questions of equity. Should a municipality bear (say) 20% of the cost of the treatment plant even when they are only responsible for 10% of the load? The inequity with respect to the Federal share is even more significant.

Based on the foregoing, the economic implications would appear to be as follows: Because of the provisions of the Act, the price being charged for public waste treatment services does not reflect the true opportunity cost of the resources being used to provide the service. Thus, society as-a-whole, rather than the polluting firm (and its customers), pays for a substantial portion of industrial waste treatment. Industry is thus encouraged to make use of a public system when a private treatment facility might provide a more efficient use of the nation's resources. Furthermore, because heavily polluting industries do not have to bear the full cost of effluent treatment, there is no incentive for them to seek alternative production processes which might result in reduced total pollution and/or be less costly to society. Since the costs of products produced by these firms are being subsidized, the prices that result give these products an advantage over substitute products for whose firms participation in municipal systems is not available. Even where the full cost of the treatment is borne by the industrial user through user fees, he continues to enjoy a return on some portion of his capital that would otherwise be fixed in private treatment facilities.

The options to be considered are the following:

- Return the full amount of industrial cost recovery to the Federal treasury for redistribution through the regular grant process, or

- Provide that both capital and interest be recovered from industrial users.

If the first option were adopted, in addition to alleviating the efficiency problems already enumerated, a larger number of plants could be funded with the same Federal budget. Over the long run, this proposal would move in the direction of program self-sufficiency and an inequity with respect to the municipal cost share would be eliminated.

The second option would, of course, make industrial user charges more reflective of the economic cost of providing abatement service to industry. If products are priced in this way, incentives will exist for industry to seek more efficient ways of treating its waste and for consumers to acquire substitute products that generate lower pollution costs. There is, of course, merit in the argument that industry should be encouraged to use municipal facilities when lower monitoring costs make it socially desirable to do so. However, the relevant question is whether, in addition to the economies of scale savings from participation in a municipal system, a substantial indirect capital subsidy should be extended to firms.

Several economic and non-economic arguments against the preceding options can be anticipated. On the non-economic side, to the extent that full industrial cost recovery effectively converts the government-industry relationship into a series of Federal loans, an administrative requirement for a different skill mix of personnel would be generated. Since either of these proposals would not reduce the need for continuing large Federal appropriations for the next five to ten years, it could be difficult to withstand the political opposition that would be generated. If either proposal dissuaded a large number of firms from discharging into municipal systems and initiating court suits in order to delay compliance, pollution abatement activities could be slowed.

Economic arguments against these options are along the following lines: First, elimination of the interest subsidies to industry would drive prices of final products higher, adding to the existing inflationary problem. A second argument is that some firms simply cannot afford to lose these subsidies; the alternative is to go out of business. A third contention is that, since residential as well as industrial users of municipal facilities pay income taxes (which are the source of funds for the Federal grant), it is unfair to require industry and not residential users to repay the principal on the Federal grant. This inequity would, therefore, be further compounded by requiring interest on the principal to be recovered from industry as well. Finally, it is often argued that elimination of the federal interest subsidy in public treatment would discourage industry from using municipal facilities.

Depending upon the firm's ability to pass along cost increases to consumers of its products through price increases, elimination of interest subsidies might well raise retail prices. The extent to which the increased costs can be incorporated into product prices 1/ depends upon the competitive nature of the industry, as well as on the elasticity of demand for the end product. The elimination of interest subsidies and the resulting increase in costs and prices of pollution-related end products would tend to encourage firms to produce (and consumers to purchase) the relatively less costly products that generate less pollution.

There is considerable uncertainty as to the effect on business failures of elimination of the Federal subsidies in public treatment. Some businesses might fail as a result of this revised policy. In most cases, these companies are marginal firms that would be closing anyway, and this result is merely speeded up by curtailing Federal subsidies. The extent of this problem merits additional attention.

The third argument concerns the equity, and perhaps efficiency, of recovery of the Federal construction grant from industry, but not from individuals. Rebuttal of the equity argument rests on recognition that considerable subsidies in private treatment are available to industry, such as tax credits, accelerated depreciation, and industrial revenue bonds. These are not available to individuals. Moreover, community residents have no options for disposing of their wastes. Charging higher prices for municipal services may not, therefore, affect individual decisions with respect to waste treatment. Industry, however, usually has feasibile alternatives of waste control, and the proper pricing of each method is an important element in encouraging the choice of the least-costly pollution control option.

The legislative history of public support for waste water treatment suggests Congressional sentiment in favor of industrial participation in public treatment. The rationale for encouraging industry to use municipal facilities is that: Economies of scale make the incremental cost of public treatment less expensive than private treatment, and, since the municipality retains one-half of industrial recoveries of the Federal grant and 100% of recoveries on the non-Federal share, larger industrial participation reduces the local waste-treatment burden.

The potential cost savings in public treatment does not by itself provide sufficient economic rationale for biasing relative costs substantially in favor of public treatment. However, the existence of substantial tax subsidies to firms opting for private treatment may provide

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1/ This does not take into account the cost of the damages that polluting firms impose on society, and for which they incur no direct cost.

such a rationale. These subsidies include the investment tax credit (or rapid amortization) and, for larger firms, industrial revenue bonds, which provide bondholders with tax exempt interest receipts and, consequently, lower interest rates for the borrower. In the presence of these private subsidies, the allocation of resources for industrial pollution control might actually be worsened by unilateral elimination of the subsidies implicit in public treatment. This is discussed in the next section, which describes the subsidies available in private treatment and then compares an example of such subsidies to the implicit public subsidy provided by not having to pay interest on the industrial share of the construction grant.

Measurement of the magnitude of the subsidy nationwide provided by the retention of monies by the municipality was not attempted in this Report. However, operational personnel at EPA suggest that without the additonal compensation provided by this provision, communities would be less able to meet the requirements of the Act. To the extent this is the case, certainly some retention of monies is justifiable.

5. Industrial Subsidies

Industrial subsidies fall basically into two classes: tax relief and low-interest loans. Both types serve to reduce the costs of pollution control projects to private firms. In the case of direct subsidies (such as grants), a simple transfer of funds occurs from taxpayers to the firm receiving the subsidy. In the case of tax relief measures and low-interest loans, the transfer is of an indirect nature. The reduced taxes paid by subsidized firms must eventually be made up for by increased revenues from other sectors of the economy. Hence, all forms of subsidy distribute the costs of pollution control from polluters to other sectors of the economy.

There are a number of Federal, state, and local tax regulations and loan programs available that reduce the costs of pollution control projects to "impacted" firms. The following Federal subsidies are available: Industrial Revenue Bonds, accelerated depreciation, the investment tax credit, and SBA loans and loan guarantees. In addition, several states permit three types of tax relief that afford some subsidization of pollution control costs: property tax exemptions, sales and usage tax exemptions, and franchise and income tax credits or deductions. This discussion, however, deals exclusively with the Federal programs. This section will describe the subsidies for pollution control equipment available in private treatment and will briefly discuss the economic effects of these measures. Then, in light of these private subsidies, a comparison is made as to the actual financial bias that exists in public versus private treatment.

Industrial Revenue Bonds:

Industrial Revenue Bonds (IRBs) are low interest, long-term, tax-free (to the bondholder) bonds issued by a municipal authority on behalf of a private company that is engaging in a pollution control program. The municipality essentially acts as a conduit for obtaining low interest funds for a company and then is also a conduit for the company's repayment of bond interest and principal to the bondholders.

The magnitude of the subsidy accruing to a firm utilizing IRBs to finance investment in pollution control equipment depends on the yield spread between the corporate and the tax-exempt bond markets. Two features of IRBs make them accessible only to large, credit-worthy firms: (1) high underwriting costs render the financing of projects costing less than $2.3 million infeasible, and (2) as in conventional financing, IRBs must be supported by the credit-standing of the individual firm.

Accelerated Depreciation

IRS #169 permits the rapid tax amortization of pollution control equipment installed between January 1, 1960, and January 1, 1975, in a plant in operation prior to January 1, 1969. Rapid tax amortization has allowed investors to depreciate in 5 years the first 15 years of the useful life of pollution control equipment.

The Investment Tax Credit:

Under this provision, instituted in 1971, a firm may deduct 7% of the value of any investment in pollution control equipment from its taxes during the first year of installation. Firms may elect to use either accelerated depreciaiton or the investment tax credit -- but not both. Analysis has shown that it is to a firm's advantage to apply accelerated depreciation to equipment with a useful life of approximately 12-22 years. In the case of equipment with a useful life of less than 12-13 or more than 22 years, it is to a firm's advantage to use the 7% investment tax credit.

Low-Interest Loans and Loan Guarantees:

As of August 18, 1974, low-interest, long-term loans and loan guarantees were made available to small firms "substantially injured" by the imposition of pollution controls. In order to qualify for these loans and loan guarantees, which are administered by the Small Business Administration (SBA), a firm must demonstrate inability to obtain conventional financing for pollution control equipment. Firms which were in financial difficulty prior to the imposition of pollution control regulations are not eligible. The SBA provides assistance only to those firms with an otherwise basically sound financial standing. The Economic Development Administration (EDA) also administers low-interest loans, but these are available only to impacted firms in designated areas of high employment.

Economic Effects of Industrial Subsidies:

The major argument that has been raised in favor of subsidizing firms' cost of pollution control is that the subsidies help alleviate the adverse financial impacts of bearing pollution control costs. Businesses affected by pollution control requirements can be divided into three impact categories: (1) those that can survive with no assistance, (2) those that can survive only with some assistance, a nd (3) those that would close in the short-run even without the added burden of pollution control costs.

The three types of available tax relief measures benefit primarily firms in the first category. However, since the long-run adverse economic impact substained by these firms will not result in plant shutdowns, the need to subsidize firms in this category is questionable. The firms who fall in the third category (those with no long-run economic viability) are beyond help. Firms in the second category stand to benefit the most from assistance, since a subsidy may mean the difference between a plant closure and survival. The SBA loan and loan guarantee programs are in theory an effective tool for alleviating the adverse impact of pollution control costs on small, marginal firms. However, these loans are not available to large, marginal firms. Though the various tax relief measures are available to this latter category, such measures provide only a minimal amount of assistance because marginal firms pay relatively small taxes. Since EDA loans are only available to impacted firms in specific, high unemployment areas, they cannot be relied upon for widespread assistance.

It has been suggested that the imposition of pollution controls results in an undue burden to plants built prior to the advent of pollution control regulations, since: (1) pollution control costs were not part of the investment decision when these plants were built, (2) installation of controls in existing plants is often costlier than installation during plant constuction, and (3) price increases to cover pollution control costs tend to reflect (be limited by) the production costs of the newer, more efficient producers. Hence, older, less-efficient firms are more likely to have to absorb a greater portion of abatement expenditures. Proponents of industrial subsidies argue that subsidizing marginal, existing plants reimburses them for their unexpected enonomic loss without unduly distorting product prices.

Currently, rapid tax amortization is the only form of subsidy which distinguishes between new and existing plants, providing assistance only to those in operation prior to 1969. However, since, in most cases, the investment tax credit provides greater benefits to the firm, this form of subsidy is rarely used.

Critics of industrial subsidies advance several arguments. First, subsidies do not provide an incentive to invest in pollution control equipment (though a stimulus to action is provided by the requirements of the Law). That is, in most instances, investment in pollution control equipment yields a negative rate of return, hence, there is no profit incentive to invest resources in pollution control projects.

Second, industrial subsidy programs are inequitable in several senses. Among firms, tax relief measures provide little assistance to marginal firms. IRBs are accessible only to large, credit-worthy firms. As an illustration, in Table 1, the dollar volume of IRBs issued (from 1971 to the first half of 1973) is displayed by size of firm. Unlike IRBs and the various tax relief measures, available SBA loans and loan guarantees do not discriminate against small, marginal firms (but they do not benefit large, marginal firms).

All subsidies are inherently inequitable in that they involve the transfer of funds from taxpayers in general to those who produce or consume pollution-causing products. Moreover, the firms utilizing IRBs benefit at the expense of upward pressure on the interest rates in the municipal bond market. This results in higher costs of financing public as well as other private projects. Moreover, since persons in higher income brackets benefit more from the tax-exempt status of the IRBs, they result in a regressive form of income redistribution.

Table 6:

IRBs Issued (by Size of Firm)

1972 Sales (Millions)	Number of Companies	Volume (Millions)	Average Amount Per Firm (Millions)
$5,000 -over	2	$ 50	$25
2,000-4,999	6	192	32
1,500-1,999	6	116	19
1,000-1,499	18	298	17
500-999	12	221	18
400-499	5	118	24
300-399	5	74	15
200-299	7	144	21
100-199	9	143	16
50-99	9	123	14
0-49	5	8	2
Total	84	$1,487	$18

Sales figures from: 25,000 Leading U.S. Corporations, Newsfront Magazine.

Third, current industrial pollution control subsidy programs are inefficient due to: (a) the inherent inefficiency of all measures designed to artifically lower the full costs of pollution control borne by certain parties, and (b) the fact that existing alternatives subsidize only certain types of pollution control costs, resulting in a bias against other methods of reducing pollution which, though ineligible for the subsidy, may be less costly to society. These points will be briefly discussed.

Efficient allocation of resources requires that product prices reflect the full economic and environmental costs of a good. Subsidizing the costs of pollution control permits lower than normal prices and sustains the sale of pollution-creating products. In the absence of such subsidies, the demand would tend to shift to products with lower pollution control costs and away from products that require highly polluting processes.

The subsidy programs currently available subsidize only the capital costs of pollution control. The result is a bias in favor of capital-intensive pollution control programs, which may be costlier than more labor-intensive methods of control. The pollution control related costs of land, buildings, and process equipment changes are eligible for the SBA loan and loan guarantee programs and for IRB financing, but not for rapid tax amortization or the investment tax credit. Consequently, there is a bias in favor of end-of-pipe methods of treatment as opposed to process changes. In spite of the advantages of subsidizing in-plant process changes, there are practical problems in setting up such a program. In many cases, the fine-line between investment for pollution control and investment for profit-making purposes is difficult to draw. Hence, defining process changes attributable to pollution control requirements is not usually possible.

Fourth, there is a potential loss of federal revenue from any of the current industrial subsidy programs. The magnitude of the possible loss varies, depending on the form of subsidy and the extent of its use.

Revenue loss from rapid tax amortization of pollution control equipment is minimal, due to its very limited use. On the other hand, the widespread use of the investment tax credit results in a substantial loss to the treasury. The potential revenue loss from SBA loan and loan guarantee programs is dependent on the rate of default, which for other, disaster loan programs has been about 5%.

The extensive use of IRBs to finance pollution control investment, as illustrated in Table 2, results in a revenue loss to the Federal government of approximately 2.5 times the amount the company saves. This occurs because approximately one half of the revenue loss accrues to the bondholder who profits from the tax-exempt status of the bond. 1/

Table 7:
(per $100 of Corp. Profit)2/

	Financing Via Corporate Bonds			Financing Via Tax-Exempt IRB's		
	Corporate Profit	Federal Tax Revenue	Investor Income3/	Corporate Profit	Federal Tax Revenue	Investor Income 3/
Gross earnings	$100.0			$100.0		
Less: interest expense	7.0	3.5	3.5	5.0	0	5.0
Net before taxes	93.0			95.0		
Less: taxes (48%)	44.6	44.6		45.6	45.6	
Totals	48.4	48.1	3.5	49.4	45.6	5.0

Notice that by using IRBs, the company saves $1, the investor gains $1.5, and the Federal government loses $2.5 = ($1 + $1.5).

1/ In more precise terms, this occurs because the marginal tax rate paid by the bondholders exceeds the product of: (a) 1 minus the marginal corporate tax rate and (b) the ratio of the difference between the corporate tax rate and the rate on IRBs, to the corporate rate.

2/ This table is based on the presentation used by Stanley S. Surrey, Assistant Secretary of the Treasury, to the Senate Committee of Finance Hearings, March 12-14, 1968.

3/ For illustrative purposes, the investor's marginal tax rate is assumed to be 48%.

Comparison of Public and Private Treatment Costs

Companies discharging pollutants "compatible" with municipal systems are likely to face lower costs from public treatment (i. e., treatment by a municipal plant) than if they were to treat privately. This is because of the economies of scale of combined treatment and because of the implicit subsidies available to industry from participating in the municipal system. For firms discharging both compatible and incompatible waste, the comparative cost of an entirely private system as contrasted with a private pretreatment system for the incompatible part (and use of the public system for the compatible part) depends on the particular circumstances. In many of these cases, however, it will also be cheaper for firms to tie into municipal systems.

Earlier, the point was made that, under certain conditions, the magnitude of the implicit subsidy to industry from participation in a municipal system was approximately equal to a 70% grant. This is correct if one assumes that a firm, if forced to build its own treatment system, would have to finance that system at an interest rate equal to its (opportunity) cost of capital. However, it ignores the tax savings that a firm can realize in private treatment, e.g., accelerated depreciation, the investment tax credit, etc. If one recognizes that some firms can finance at least part of their own systems through Industrial Revenue Bonds, and if one allows for the effects of faster depreciation rates and interest expenses, the resulting subsidy in public treatment is virtually eliminated, and, in many cases, less than the subsidies available in private treatment.

A comparision between the subsidies available in public and private treatment can be illustrated by a brief example. Suppose that a firm would have to expend $100 in construction costs either for private or for public treatment. The real costs borne by industry in public treatment are shown in Table 8, while Table 9 indicates the industrial costs in private treatment. The assumption in Table 8 is that, at after-tax (opportunity) costs of capital of (say) 4.5% and 9.0%, full recovery of Federal and local cost shares will take place over 30 years. Interest on the 75% Federal share is recovered at 7%, the Federal borrowing rate. Interest on the 25% local share is recovered at only 6%, due to the tax-free nature of municipal borrowing. The (present value) projected costs of participation in the public system at (opportunity) costs of capital of 4.5% and 9.0%, are $62.54 and $41.65, respectively. In Table 9, the range of costs that are shown for the 4.5% and 9.0% cost of capital figures are based on the following: the lower end of the range is calculated based on private construction costs depreciated over 20 years but paid back over 30 years; the upper end of the range assumes 20-year repayment, depreciated over 30 years. This covers the spectrum of most-favorable to least-favorable repayment terms. For after tax (opportunity) costs of capital of 4.5% and 9.0% respectively, the following ranges of costs in private treatment are shown: (1) $45.25 to $53.41 (for private borrowing at 6%) and $66.25 to $69.57 (for private borrowing at 10%), (2) $24.23 to $37.25 (for private borrowing at 6%) and $34.43 to $49.78 (for private borrowing at 10%).

Table 8:

INDUSTRIAL COST OF PUBLIC TREATMENT

	After Tax Discount Rate (Opportunity Cost of Capital)	
Cost Categories for Full Cost Recovery	4.5%	9.0%
75% Federal Share	$21.18	$13.35
25% Local Share	7.06	4.45
6% Interest Rate on Local Share	7.57	5.70
Present Value Cost	$35.81	$23.50
Plus 7% Interest Rate on Federal Share (Not Currently Recovered)	$26.73	$18.15
Projected Present Value Costs for Full Cost Recovery	$62.54	$41.65

Table 9:

INDUSTRIAL COST OF PRIVATE TREATMENT

	After-Tax Discount Rate (Opportunity Cost of Capital)	
Interest Rate on Private Borrowing	4.5%	9.0%
6%	$45.25 - 53.41	$24.23 - 37.25
10%	66.25 - 69.57	34.43 - 49.78

A comparison of these tables shows that, in the absence of paying the interest on the Federal share, a financial bias exists in favor of public treatment. However, if interest charges were recovered from industry, the financial bias would be eliminated. In fact, in this example, there is a financial bias in favor of private treatment.

Another factor, not taken into account in the example, will tend to make the bias in favor of private treatment even higher. Most firms discharging into municipal systems pay user charges based on average, not marginal costs. The greater the economies of scale of the treatment system, the more average costs will exceed marginal costs, and, hence, the more firms will be "overcharged" relative to their use of the resources.

If full industrial cost recovery (or even recovery of the interest on the Federal loan) were instituted, in order to prevent a bias toward private treatment, the use of private subsidies, such as Industrial Revenue Bonds, would have to be prohibited. This brings to the fore a dilemma. The private subsidies are outside the sphere of direct EPA influence. Yet without their curtailment along with a requirement for recovery of the interest on the Federal share, a bias for private treatment would certainly ensue. Currently, particularly for firms that can utilize IRBs, the existence of both (the interest-free) public and private subsidies may at times result in a net advantage for private treatment. Though it would be advantageous to society to dispense with both types of subsidies, if private subsidies are to continue, it appears worthwhile to retain the public (interest) subsidy as well.

V. OTHER ALTERNATIVES: TRUST FUNDS AND LOANS

A. ENVIRONMENTAL TRUST FUNDS

This section on Environmental Trust Funds is a brief synopsis of a complete study of Trust Funds prepared for the Environmental Protection Agency by RIVUS, Inc., a firm associated with John Hopkins University. This latter study is also being submitted to the Congress at this time (see Appendix D).

Financing arrangements that include trust funds have traditionally had the following in common: (1) An earmarked tax, the receipts from which are dedicated to a specific purpose; (2) Separate accounting of receipts from the earmarked tax and disbursements for the stated purpose (the "trust fund"); (3) General awareness, on the part of Congress, of the dedicated nature of the revenues at the times of authorization and appropriation. Because of these characteristics, the case for and against an environmental (or any) trust fund can be made independent of its sources of funds and methods of disbursement (generally grants or loans).

The use of trust funds has developed over the years as a method to isolate and protect a program from year-to-year competition for funds in the executive budget and legislative appropriation cycles. Programs supported by trust fund revenue allocations are generally thought of as having stable social or economic values where predictable revenue flow is essential to support these values. Trust funds are an off-budget method of program financing that limits, to a degree, the level of control exercised over the program by the executive or legislative branch once the program is established. However, this has been changed by P.L. 93-344, the Congressional Budget and Impoundment Control Act of 1974. Annual Congressional review and approval must now occur before funds can be allocated to potential recipients. The essentially automatic availability of monies for trust fund purposes no longer exists.

There are several ways to supply revenues to the fund under the trust fund concept and also several ways to manage the placement of the funds. To provide a framework, these options will be discussed briefly in this section. In addition, the economic effects, feasibility and the effectiveness of trust funds as related to the present program will then be dealt with. Specifically, the discussion will cover five topics. These are:

- o Types of Trust Funds;
- o Source of Funds;
- o Disbursement of Funds;
- o Economic Effects;
- o Feasibility of Trust Funds; and
- o Effectiveness of Trust Funds.

TYPES OF TRUST FUNDS

The variations on the trust fund concept come from different methods to supply the funds and different methods of fund disbursement. In general, there are two types of trust funds:

- o The Closed Trust Fund; and
- o The Open Trust Fund.

Closed Trust Fund

A closed trust fund is characterized by a designated supply of funds (earmarked taxes) and a defined end use (separate accounting of receipts) of the funds (e.g., constructing wastewater treatment plants). Revenues from an earmarked tax are directed through a trust fund to an operating agency where they are made available for obligation by means of contract authority. The earmarked taxes and the designated end use are set by Congress or a State legislature, and the trust fund and program operate independently thereafter. The revenues are allocated to the end use by the contract authority, generally by criteria or formula established by the legislative body. It is assumed that an environmental trust fund would most likely be of the "closed" variety.

Open Trust Fund

In an open trust fund, the object of the earmarking is also supported by revenue from Federal funds, and unobligated revenues from the special fund may be, under certain conditions, diverted to other purposes or into Federal funds. That is, the open trust fund can have both earmarked and non-earmarked taxes, and, on the disbursement side, some revenues are available for general as well as special purposes. Revenues from existing taxes, both earmarked and non-earmarked, can be directed through a trust fund to an operating agency where they are made available for obligation by means of contract authority. The earmarked and non-earmarked taxes are supplied at a rate set by the Congress, and the non-earmarked portion can be adjusted annually. The end use of funds is specified by the Congress. As a result of these characteristics, it is often difficult to distinguish an open trust fund from normal appropriations financing. The advantage of the open fund arises only when the pool of capital exceeds designated end use requirements and the excess funds can then be used for general governmental purposes.

SOURCES OF FUNDS

As mentioned above, there are two sources of revenue for an environmental (or other) trust fund: Earmarked taxes or an allocation to the fund of general tax revenues. Earmarked taxes that are benefits-related (such as user charges) are used most frequently with trust funds because the tax itself rests on those who benefit from the program expenditures. In this section earmarked revenues will be discussed both as benefit-related and as deriving from existing (non-benefit related) taxes.

Earmarking Receipts from Benefit-Related Taxes

Where a tax base can be identified that is related to the benefits expected from the program, an earmarked tax can be postulated which may have important advantages over the non-benefit related case. In the case of the Construction Grant Program, taxes on the use of the wastewater treatment system (user charges) or on the use of the benefitted water resource (water use taxes) are alternatives, although the latter may be impractical.

Since the quantity of revenue available is related to some measure of the benefits provided by the program, the quality of the allocational decisions made by Congress may be somewhat better with benefit-related taxes than is the case with earmarked existing taxes. The linkage provided between taxes and expenditures tends to promote efficient decisions. This advantage, however, is dependent on the nature of the taxed activity and the willingness of Congress to adjust the tax rate to maintain the program at its optimum efficient size.

To the extent that the incidence of the tax conforms to that of the benefits, the use of a benefit-related tax confers important advantages in the way of equity, as measured by the benefit principle of taxation. Furthermore, to the extent that a program supported by a benefit-related tax assumes a level different than it would have reached if supported by general taxes, the preferences of the beneficiaries are being served without cost to the non-beneficiaries -- a contribution to efficiency. However, with respect to the ability-to-pay principle, because the tax is normally an excise tax or user charge, it is relatively regressive in its incidence with respect to income.

The most notable example of the earmarked, benefit-related tax is the gasoline tax used for the Federal Aid Highway Program. The major criticisms of the tax, which are also applicable to all earmarked taxes, center on the divergence between the incidence of the tax on all users of gasoline and the benefits, which are largely biased to the heavy users of interstate highways.

Another criticism has been that the allocational decisions are made by Congress on the initiative of the Committee on Public Works rather than the Committee on Appropriations. This tends to lead to inefficient program levels because Public Works has specific program interests and does not compare its program with other programs to determine the most efficient use of funds. The fact is that the Committee on Appropriations has the means to coordinate spending decisions associated with the Highway Trust Fund (as it would with an environmental trust fund) with those in the Federal sector as a whole, should it choose to do so. But there is no assurance that the resulting decisions would be preferable to those now being made, since the apparent opportunity cost of the revenues in the trust fund is distorted by the fact of earmarking. The Highway Trust Fund is vulnerable to criticism on both efficiency and equity grounds, but it has been a notably effective means of financing a major public works program.

Earmarking Receipts from Existing Taxes

Since, with existing taxes, the earmarked supply of funds is not related to the activity or value provided by the program nor to those who benefit from it, the allocational decisions that are made by Congress may bear little relationship to program needs or benefits. To the extent that a program supported by existing taxes assumes a level different than it would if supported by benefit-related taxes, non-beneficiaries may subsidize beneficiaries. This is economically inefficient and, under the benefit theory of taxation, inequitable.

However, the use of existing taxes is more favorable in terms of income distribution effects. The allocation of existing tax receipts to a trust fund would imply heavy reliance on personal and corporate income taxes. These taxes are generally considered relatively progressive in their incidence with respect to income. The major impact of the personal income tax is the displacement of private consumption. Corporate income taxes displace investment to some extent, but they are also believed to act primarily on private consumption. Hence, except for certain widely publicized defects in the income tax structure, the burden of raising revenues in this instance tends to fall equally upon equals, i.e., it is consistent with the ability-to-pay principle of taxation.

DISBURSEMENT OF FUNDS

Trust funds are a method of segregating a pool of capital for a special end use. The funds, typically, are provided in a grant to another agency or to another level of government. The other option in disbursing funds under the trust fund concept is to loan monies to another governmental body.

The method of disbursement in a trust fund is not different from the expenditure methods of any government agency. Trust funds are often required to spend their money according to a formula (e.g., dollars per capita by state) to assure equitable distribution of funds, but these convenants often accompany regular agency appropriations as well. Since many of the agencies receiving funds from annual appropriations have loan and grant programs, there is nothing in fund disbursement that is a unique characteristic of trust funds.

ECONOMIC EFFECTS

The most strenuous opposition to the use of trust funds to finance government programs has focused on the equity and economic efficiency of financing arrangements. Trust funds have been accused of misallocating resources. They are believed to: (1) stimulate over-investment; (2) to encourage programs to grow autonomously; (3) to permit programs to outlive their justification; (4) to allow program beneficiaries to profit at the expense of taxpayers as a whole; (5) to introduce unwanted rigidities into government decision-making; and (6) to hamper economic stabilization policy and fiscal management by accumulating huge cash surpluses which must (by statute) be invested in government securities.

At the same time, others believe that the use of trust funds may tend to allocate resources in a manner more responsive to public preferences, that it may increase public satisfaction with government programs, that it may alleviate pressures to consider only short-run goals, and that the proper choice of taxes for earmarking may improve equity effects as compared to those obtainable without earmarking.

The central discussion of economic effects centers on the issue of allocational efficiency. The executive agencies and the Congress propose allocations and finally allocate resources based on very specific interests. Each agency views its own mission independent of the demand for resources of other agencies. This is "brokered" to some extent by the Office of Mangement and Budget, but inefficiencies remain. Also, Congressmen often tend to view political opportunity and needs back home somewhat independent of the best possible use (opportunity cost) of public funds.

Allocational efficiency is difficult to achieve under most conditions, but given the highly specialized view points of agency administrators and individual Congressmen, the prospect of equating benefits at the margin for all government programs is not promising. This problem is further compounded by the lack of data or inconsistent data on the costs and benefits of various programs. However, reasonably efficient allocations of resources are made by Congress when the issues are important and the fund level is significant.

Depending on the type of financing used for a trust fund, this mechanism can adversely affect the incentives ordinarily present for efficient allocation. If the funds are earmarked taxes, the unavailability of these funds for other purposes acts to reduce the opportunity cost of such revenues considerably below that of general revenues. The only alternate use of earmarked taxes to investment in the designated program in the current year is investment in the same program in future years. Provided that the earmarked tax levy has not been an onerous or unpopular one, political opportunity costs will probably be low as well. In these instances, there is reason to believe that Congress will tend to expand the program to levels beyond those which would be expected in the absence of earmarking.

There is an incentive for this expansion to continue until revenue available from the current tax levy (the specification of tax basis and tax rate) are exhausted, unless national priorities are altered and the funds re-allocated. At this point, the considerable friction which exists in the taxing process will act as a brake on further expansion, although for reasons unrelated to economic incentives. Programs funded by earmarked taxes levied upon bases which tend to grow faster than program requirements will, under these assumptions, be subjected to accelerative pressures. Programs whose tax bases are shrinking relative to program size will, for the same reasons, receive decelerative pressures, even in the presence of Congressional incentives to increase expenditures.

The efficiencies of allocation deteriorate further if the allocation of earmarked funds is handled separately from non-earmarked funds. In most trust funds, the allocation decisions arise only if the trust fund's legislation is expiring or a sharp controversy over the program develops. Thus, the trust fund is part of the allocation process and the question of the opportunity cost of these funds emerges again.

It does appear, however, that the Congress is unlikely to establish a trust fund for the purpose of financing a construction grant or other government program which will reduce its range of choice in allocating public revenues unless it can be demonstrated that signficiant advantages can be achieved.

FEASIBILITY OF TRUST FUNDS

Trust funds are, in general, legally, politically, and administratively feasible. There are several working examples, the most notable being the Highway Trust Fund. Hence, the major issue is whether a trust fund would be more or less complex and expensive for program administration than the present grant program. It appears that the only substantive difference administratively would be in the choice of revenue sources. The use of benefit related taxes, which appear desirable on economic grounds, may be less desirable than funds from the budget because of difficulties in implementation and enforcement. Such taxes characteristically involve administrative costs which are larger than those associated with general taxes and which could obliterate any hoped-for gains in allocative efficiency. Not all tax proposals share this deficiency, but it demands consideration wherever a new or innovative tax levy is contemplated.

EFFECTIVENESS OF TRUST FUNDS

Most support for trust funds appears to stem from their alleged advantages with respect to program effectiveness. The Construction Grant Program is largely dependent, for its success, on the voluntary applications of thousands of local governments and government authorities for grants. This procedure is fortified by a strong enforcement program which requires permits and in which penalties are levied for non-compliance. It has been argued that the Federal government must demonstrate its commitment to the programs by providing an adequate and stable financing arrangement so that individual wastewater utilities will be encouraged to proceed with the planning and programming of needed facilities. This argument was instrumental in Congress' decision to remove the Construction Grant Program from the normal appropriations process and to provide contract authority. Still, it may be suggested that a trust fund would further emphasize the Federal government's determination to support the program, it would provide incentives for local governments to participate without further delay, it would protect the scale and momentum of the program through temporary revisions in Congressional priorities, it would offer some shelter from the threat of Executive branch impoundment of funds, and it would allow realistic long-term commitments to major abatement programs now dependent upon piecemeal grants.

The recently enacted Congressional Budget and Impoundment Control Act of 1974 requires that new contract or budget authority contain a provision that such new authority is to be effective only to the extent or in such amounts as are provided in appropriation acts. Furthermore, with the annual Congressional review and approval procedure, the "protective" aspect of trust funds is significantly reduced.

The real question is whether the existing grant financing arrangement can be made more effective by means of an environmental trust fund. On the basis of the available evidence, trust fund financing arrangments have little to offer by way of improved effectiveness at the present time. Unless the "trust fund mystique" improves State and local confidence in the current program, which seems doubtful, there is no reason to expect any improvement in effectiveness over the existing financing arrangements. The arguments for trust funds along lines of constancy and commitment are no longer as important as they have been in the past.

TRUST FUNDS IN PERSPECTIVE

The argument for an environmental trust fund, which might be financed by surtaxes, contributions, effluent fees, excises, etc., is that environmental controls, and specifically water pollution control, will be a continuing necessity for our society. They might, then, deserve a sustained source of revenues. A trust fund can function in a variety of means, as a special-pwrpose bank, a loan-guarantee mechanism, or a grantor of facilities. It would provide a measure of continuity and independence to the conduct of water quality control activities. This might result in better investment decisions (longer run considerations taken into account), and it might reassure local governments of a longer term commitment to the program (which will aid program functioning). However, as mentioned earlier, the enactment of P. L. 93-344 considerably reduces the primary benefit to be gained from a trust fund: a virtually automatic source of funds.

The arguments against such a fund are the arguments made against trust funds in general. For the most part trust funds are criticized because of their: inflexibility; nonresponsiveness; administrative costs; and tendency to encourage questionable projects. The inflexibility comes about whenever funds are placed in trust or earmarked categories to be used only for specified purposes irrespective of need. Nonresponsiveness occurs because the fund size is not related to the requirements of the fund's purposes. Administrative costs of trust fund arrangements, although not necessarily exorbitant, reduce the amount of money available for fund purposes. The availability of funds in the trust-account set aside for specific types of programs often encourages implementation of projects of marginal or questionable value.

Since a trust fund is mainly an accounting technique to protect funds for a program, it will have little impact on the effectiveness of the construction grant program. On balance, there do not appear to be compelling reasons to recommend a trust fund as a financing arrangement for the Construction Grant Program.

B. ENVIRONMENTAL LOAN PROGRAM

This section discusses the overall feasibility of a federal low-interest loan program as an alternative to the existing grant mechanism. Like a grant program, a federal loan program initially involves a direct transfer of funds from a federal agency to a state or local government. However, the major difference between a loan and grant program is that a loan must generally be repaid over a set time period, with interest charges levied for use of the funds.

Since the current grant program reduces the local cost of compliance and a federal loan program at market interest rates does not, the latter is not a real option to the current program. That is, at market interest rates, a federal loan program would change the financing of the program from a substantial subsidy to a non-subsidized program, in which the costs to a municipality would be higher than 100 percent municipal grant financing. Clearly, to consider loans as an option to the grant program, a subsidy (low-interest loan) of some level is needed.

Historically, the Federal Government has been a large supplier of credit to both the public and private sectors of the economy. For the most part, the private sector has been the biggest beneficiary of loan subidies. A wide range of loan programs with specially tailored provisions has not historically evolved to benefit State and local governments; hence, loans have not been thought of as options to grants.

In general, the federal loan programs that have aided local governments can be classified as having one of two purposes. The first is to offset capital market imperfections. It is often extremely difficult for a small community to raise even small amounts of long term capital by issuing municipal bonds for general sale. This difficulty cannot be explained fully by the community's credit rating. In most cases, smaller communities borrow at higher cost than larger communities in the same risk class. This occurs because (1) the fixed costs associated with debt issues are often large enough to make small bond issues relatively more expensive and hence impractical, and because (2) smaller communities, being infrequent borrowers, usually do not have a financial rating. The economies of scale in debt issues in the financial markets benefit the large communities but work to the disadvantage of smaller communities. To overcome these capital market imperfections, the federal government can choose to establish a direct loan program. Even by charging the current market interest rate to the community, the federal government does remove artifical roadblocks to borrowing. That is, the federal government enables the smaller community to have access to capital at the market rate for its risk class rather than suffer the prospect of no capital or capital at prices higher than warranted by its risk class. This enables the community's local investment priorities to be implemented. Of course, the Federal Government incurs administrative costs.

The second purpose of a federal loans program is to encourage investment in specified activities by supplying funds at an interest rate below the rate at which the community could otherwise have obtained the loan. It is the difference between market and sub-market rates that measures the subsidy to the borrower and presumably induces added investment in the favored activity.

It is this latter type of loans program that is of primary interest in this section. A loan program that serves to remove capital market impediments might serve a useful purpose in combination with a grant program but not as an alternative. At this time, capital market impediments do not seem to be dissuading smaller communities from participating in the grant program. For those communities unable to raise their 25 percent share, the Environmental Finance Authority (EFA) is presumably available to provide assistance. However, as of December 31, 1974, there have been no municipal applications for loans placed with the EFA. One reason is that many states supply some portion of the local share, leaving the community with a modest capital requirement that does not consume a major portion of its debt capacity.

Revenue Sources

There are three types of revenue sources for a loan program: general revenues, earmarked taxes, and debt issues. First, general revenues from the treasury, which use a combination of debt, taxation and proprietary receipts, can be allocated to a loan program. This is, of course, the source of funds for the current grant program. Second, earmarked taxes can be levied to raise funds for a loan program. This tax can be a benefit-related excise tax or a percentage of an existing tax. In most cases, the special tax is earmarked for the program and is not available for other uses. Third, debt can be raised to fund the program, and the debt receipts can be exclusively earmarked for this program. This technique is available for use by the Environmental Finance Authority.

The revenues generated by debt issues are raised by borrowing from individuals, commercial banks, other financial institutions, corporations, and from the sale of bonds to the Federal Reserve banks. Since lending, unlike taxation, is voluntary, individuals and organizations usually do not curtail consumption or investment to buy bonds. In most cases, the purchase of bonds represents a diversion of current or accumulated savings into government bonds.

When individuals buy bonds, the most likely shift of the funds will be from equity securities or savings to the government bonds. In the case of securities, the shift will tend to depress security prices and make the sale of additional stock more costly to a corporation. To the extent the funds are shifted from savings to bonds, and interest rates rise, private investment will be reduced (especially in housing and construction projects).

Borrowing from the financial institutions and corporations results in shifting funds away from other investments, most notably other securities. The sale of bonds directly to the Federal Reserve banks are credited to the accounts of the government with that bank. When these accounts are drawn upon by the government and paid to other persons, the recipients will typically deposit the sums in their own banks and thus increase the total deposits of the commercial banks. Sale of bonds to the "fed" generally does not curtail funds available for other loans, and is, therefore, more expansionary than the sale of government bonds directly into the private market.

For any one program, the national impacts of borrowing are so small they are not noticeable. However, in considering national economic policy, it should be recognized that a new program using debt financing would add to the existing body of national debt and expand the effects just mentioned.

Financial Equivalence of Loans and Grants

The distinction between a grant and a loan program can be modified by the terms and conditions designed into each program. The two characteristics of a loan program that essentially determine its financial impact are the interest rate and the repayment period. From the municipality's point of view, unless it can borrow at a cost below the prevailing market cost, there is no reason for the community to borrow from the federal government. 1/ Thus, the interest rate to be charged must be below the municipal rate that could normally be obtained. Of course, an interest subsidy alone may not induce investment that a municipality would otherwise not choose to make. In the case of pollution control, rigorous enforcement of the NPDES to assure compliance can serve as an additional inducement to required investment. When enforcement programs are combined with an interest subsidy, these two features are likely to provide an incentive for municipal investments.

Furthermore, the terms of a loan program can sometimes be more readily tailored to meet program objectives than can the terms of a grant program. For example, the repayment provisions of a loan require municipalities to bear the capital cost of the treatment facility, while a grant shifts some portion of that cost to the federal government. Thus, a loans program would tend to encourage municipalities to design their treatment facilties efficiently to minimize the debt and the annual payments, and to leave as much municipal debt capacity as possible for future uses.

1/ Unless, of course, the government program removes "roadblocks" to obtaining funds in the capital market, i.e., enables communities, usually small and without bond ratings, to secure capital otherwise not available without a substantial interest penalty.

Also, because these loan repayment requirements generate a cash flow to the lender that can be reloaned, the argument is often made that a loan program can ultimately reduce the federal financial role in the waste-water treatment program. The idea is that the program can become partially or completely self-financing and thus reduce federal budgetary outlays. Obviously, a loan program that is equivalent to a grant program will not reduce federal participation. The Environmental Finance Authority secures funds through the sale of bonds at market rates and then provides these funds to municipalities at the Baa tax exempt rate. The difference between the taxable market rate for federal bonds and the tax exempt Baa municipal market rate is the federal cost of the subsidy. The federal losses resulting from this financing technique are paid for by budget outlays. Obviously, there is an inverse relationship between the interest rate charged to municipalities and maintenance of a particular level of federal financial support. Thus, to reduce the federal financial role in wastewater treatment, a loan program tailored to provide less subsidy than the current grant program could be established. This, of course, does not mean that the total resource cost of improving water quality to the nation as a whole is necessarily reduced.

In discussing loans versus grants, the concept of financial equivalence will appear frequently. The equivalence concept will be used to illustrate differences and similarities between grant and loan programs. In most cases, a loan program will be considered equal to a grant program if the annual cost or cash flow burden to a community is the same for both programs or the discounted costs of the project are the same. The effects of a grant or loan program on future municipal expenditure possibilities, though briefly discussed, are so community-specific that generalizations as to equivalence on this basis are difficult to make. The equivalence criteria implicit in the comparison of grants and loans include equality of:

1. discounted costs,
2. annual payments, and/or
3. effects on future expenditures for all municipal investments.

The question of interest is, what interest rate and what repayment period are necessary to achieve comparability with a particular grant program, resulting in either case in equivalent costs to the community (either on a discounted cost or annual payments basis) for the same facility? As the interest rate and/or repayment period varies, it is possible to create a financing program for loans that is comparable and has nearly the same impact as certain grant programs with matching requirements.

A brief illustration of the (subsidized) interest rates required to achieve financial equivalence with a federal grant is presented below.

Project Capital Cost of $10 Million

Federal Grant Rate	Federal Grant $	Remaining (Local) Share Borrowed at 6% - 20 Year Period	Annual Payment	Equivalent Interest Rate Based on $10 Million Present Value - 20 Yr Period
20%	$2,000,000	$8,000,000	$697,476	3.4%
30%	3,000,000	7,000,000	610,791	2.0%
40%	4,000,000	6,000,000	523,107	0.5%
50%	5,000,000	5,000,000	435,922	-
60%	6,000,000	4,000,000	348,738	-
75%	7,500,000	2,500,000	217,961	-

The table shows that the subsidized interest rate required to achieve financial equivalence between a loan and a grant program depends on the Federal cost share. For example, looking at the first row, if the local share (in this case, 80%) of a Federal grant program with a 20% Federal cost share was financed by a 20-year, six percent loan, the local financial obligation would be the same (in present value terms) as that incurred by a 3.4 percent loan covering the entire project cost. However, in order to achieve financial equivalence between a 40% Federal grant share (with the 60% local share financed on the same terms as before) and a 100% loan, the subsidized interest rate must decrease to .5%. For Federal grant rates much above 40% and the local share raised by an unsubsidized local borrowing rate of 6% over 20 years, financial equivalence requires a negative Federal loan interest rate.

A second way of looking at financial equivalence is illustrated in the Table below:

Loan Rates Charged Municipality (%)	Rates Paid for Federal Borrowing (%)	Grant Rate that Achieves Equivalent Federal Cost (%)	Grant Rate that Achieves Equivalent Subsidy to Community (%)
1	7	41	36
2	7	35	30
3	7	29	23
4	7	22	16
5	7	16	8
6	7	8	0

Assuming that the Federal Government must pay 7 percent to raise funds, column 3 of the Table shows the grant rate that incurs the same Federal cost as making a 100% low interest loan at the rate shown in column 1. That is, column 2 (7%) minus column 1, is the percent (degree of) Federal subsidy provided. This increment is then used to compute a grant rate that achieves equivalence.

Column 4 indicates the equivalent grant rate if account is taken of the interest subsidy already often available to the community, i.e., since community borrowing itself is subsidized by the tax-free nature of the interest payments, communities can often obtain funds at rates below those paid by the Federal government. If this rate is 6%, the (subsidized) interest rate used to compute equivalence is 6% minus column 1. This difference is the degree of the percent loan subsidy provided to the community by the environmental loan program.

The table shows that even with an interest rate as low as 1 percent, the grant equivalent subsidy received by a municipality would represent only 36 percent of capital costs. If the interest rate was set at 2 or 3 percent, the equivalent grant subsidy would be only 30 or 23 percent, respectively. Obviously, these subsidy payments would be far below that provided by the current 75 percent construction grant and might retard investment spending by communities for water pollution control.

Under a loan program, some communities might be more concerned with the size of their annual payments than with the present value of the local financial obligation. For such cases, examples of financial equivalence can also be constructed. For instance, the annual payments on a $10 million, 30 year, zero-interest Federal loan are actually less than those required for a 50% grant in which the local share is borrowed at 6% over the same period. Likewise, a 25% Federal grant with the 75% local share financed by a 20-year, 6% conventional municipal bond requires the community to make larger annual payments than a 20 year, 2% Federal loan in which straight time payments are made. The payment period for most municipal bonds actually ranges from 15 to 25 years for major facilities. To make a loan program attractive, it is possible to stretch out the debt retirement schedule to the full life of the asset or beyond. Payment schedules that span 30 to 40 years are now used in municipal finance and can be considered as a method to soften the annual payment burden of a loan program.

Although the level of subsidy and thus presumably the impact of either a grant or loan program can be equalized over a wide range of conditions, one prominent feature of a loan program's interest subsidy remains to be considered. The subsidy to a municipality under a loan program occurs over the entire length of the loan, whereas a grant subsidy is received fully when funds are transferred for facility construction. Once the grant has been paid, there is less possibility for federal influence over the project. This loss of federal financial influence may provide less incentive to municipalities to achieve and sustain a high level of facility performance than would a loan program.

Since a loan program's subsidy is not fully delivered when the facility is completed, the federal financial role is an ongoing one. This suggests that a certain degree of control over treatment plant performance can be retained by making the interest subsidy conditional on continued satisfactory plant operation. For example, a sliding interest rate ranging between the maximum subsidy rate and the market rate could be established and reset each year after evaluating each facility's performance. Thus, a poorly operated facility would receive little or no subsidy, while one achieving satisfactory operation would receive the entire amount. This sort of adjustment could be made for each annual payment. Such inducements to efficient operation could be achieved with no net increase in Federal program disbursement costs (unless the costs of administration and enforcement were to increase).

Administrative Requirements

A loan program would require two types of program evaluation by the administering agency's staff. The first would involve credit analysis of the borrower's ability to repay the debt obligation. The second would be an examination of the proposed facility plans to insure that all federal requirements were being satisfied.

The legal obligation for debt retirement is an important feature in a loan program. The administration of a loan program can be very expensive or reasonably inexpensive depending on who has the legal obligation to retire the debt.

In the less expensive category, long term debt obligations secured by the full faith and credit of the municipality (the general obligation bonds) are very low risk debt issues. The full faith and credit pledge is based on the general revenues of the issuer and all resources accountable to the issuer. When a municipality issues a general obligation bond, very little credit analysis is required by the prospective investors. This reduces the administrative costs of issuing the bonds. If a federal loan program were to require of municipalities the full faith and credit pledge, then the need for a financial review of the municipality would be minimal. The staff to review loan applications in such a program would be quite modest.

However, if a federal loan program was established that directed municipalities to establish a separate agency or authority to construct the facility and retire the debt, then the administrative complexity would increase substantially. Basically, the federal lending agency would have to examine the adequacy of the municipal revenue generation system (e.g., user charges), the elasticities of demand, the relationship of revenues to capital and operating costs and so on. In essence, extensive financial analysis would be required to assure that the loans would be paid back. In practice, this procedure of in-depth analysis is normal with municipal revenue bonds. If this type of bond was permitted, it would require an extensive federal staff of analysts to review the municipal loan applications. Thus, the administrative requirements of a loan program depend on the legal obligation for repayment.

In addition to the financial review, a loan program would require a technical review similar to that required under the existing grant program. However, a loan program might require substantially less staff and administrative expense than the current program. If a community must borrow a major portion or all of the funds to build a wastewater treatment facility, it is not as likely to build an excessively large facility. The requirement to pay will tend to encourage efficiently designed systems. Thus, less extensive design review is necessary to check wasteful use of grant funds. As in the current program, a strong monitoring and control unit can investigate the performance of the facilities to insure that the desired standards are being met. Expensive penalties for non-compliance can be assessed, which will also encourage adequate and thorough design. Thus, a strong monitoring function can serve to reduce design review as well as to assure compliance.

Economic and Financial Effects

Loan and grant programs that are financially equivalent may still have different economic effects. From society's point of view, this implies differential impacts on the efficient allocation of resources and on the distribution of income.

Loans are generally inequitable inasmuch as they redistribute income from the poor to the rich. This regressivity comes about because loan repayment for waste treatment services generally comes from user fees, sales taxes, and property taxes. The growing propensity for local government to fund waste treatment services out of user charges rather than general revenues has resulted from statutory constraints on issuance of general obligation bonds, the growth of industrial wasteloads, and the inability of normal sources of income to meet the rising costs of waste treatment. In contrast, the current grant program revenues come primarily from the progressive income tax. Loan program funds raised from benefit-related taxes (such as user charges) are, however, consistent with the benefit theory of taxation: the program beneficiaries are the ones who pay for the loan.

In evaluating economic efficiency, the question of interest is, to what extent do loans alter the choices or courses of action on the part of members of society? The answer depends on how funds are raised to support the program. If tax-financed, the effects are similar to those described in the section on Trust Funds. Tax increases tend to reduce personal consumption. However, if the funds are from benefit-related taxes, and to the extent that preferences of beneficiaries are being served without cost to the non-beneficiaries, this is a contribution to efficiency. If funds are raised from general taxes, non-beneficiaries may subsidize beneficiaries. This can be economically inefficient (and, under the benefit theory of taxation, inequitable). Of course, these statements also apply equally to grants.

If, however, a loans program is financed by debt, the economic efficiency of loans as compared with grants may not be as apparently neutral. Debt financing will result in negative impacts on the capital markets. That is, there would be an increased demand for loanable funds and thus a tendency for interest rates to rise. The total volume of investment is sensitive to interest rate changes, and a rise in rates tends to discourage or defer some investments. For example, the building construction and housing markets tend, in general, to contract as interest rates rise. To the extent government bonds attract funds away from securities, security prices will fall and there may be modest effects on business expansion in that additional stock would be more costly to corporations. Even though it is unlikely that any one government program would have a significiant impact on the overall availability of funds and the cost of capital, a program funded by loans would add an increment to the effects generated by the existing body of federal debt.

With debt financing, the issue of intergenerational equity is sometimes raised. There is a popular argument that when funds are borrowed, the present generation escapes an economic burden that is imposed on future generations (who must pay the interest and principal on the loan). Most economists disagree. The real burden is borne in the period in which the expenditures occur, because it is then that resources are diverted from private to public use. The diversion occurs due to reduced consumption and investment, regardless of the financing method.

Though future generations inherit an obligation to pay interest and principal, they also inherit the bonds. Therefore, the interest and principal only represent a transfer payment within the future generation. Except for some decrease in net capital formation, there is no reduction in real income in the future due to government borrowing. In recent years, a few economists have redefined "burden" in terms of individual attitudes toward their economic well-being (rather than in terms of private sector outputs and real income). Once this definition is accepted, a case can be made for some shifting of individual burden (though the argument will not be presented here). Most economists would agree that this approach overemphasizes the individuals involved.

When considering the impact on abatement efforts that could result from substituting a federal loan program for the existing grant program, two types of questions can be identified. First, will there be any impact on the level of municipal involvement in the water pollution abatement program? In other words, will a loan program be viewed as more or less desirable by individual communities who ultimately have the responsibility for facility planning and constraints? And second, will there be any impact on the technical efficiency of those abatement efforts that are actually undertaken by the communities? The question of efficient abatement can then be further subdivided into a facility design stage and a facility operations stage.

The level of municipal involvement in the water abatement program presumably depends on both the federally mandated timetable for pollution control, including whatever enforcement procedures to insure compliance that are instituted, the cost to the municipality of participating, and the perceived benefits accruing to the community. Both grant and loan programs reduce the cost of water pollution control to the community and thus are expected to act as an incentive for the community to undertake an abatement project.

If the subsidy provided by either a loan or grant is identical, a community would be financially indifferent between programs, and both would have an equivalent impact for inducing investment in water pollution control. However, cost may not be the only criteria by which a community judges a program. At the municipal level, a grant program requiring a local share may be preferable to a loan program for political reasons, even if the programs are economically equivalent. Public acceptance, and perhaps public acclaim, result more readily from receiving a grant even though the local share is likely to be raised by debt. Most citizens simply do not understand the equivalence; they generally think that a grant is "free," while a loan costs more regardless of the financial equivalence. Also, there is public appeal in being able to gain leverage of the municipal dollar. A loan program does not offer leverage 1/ to the public, while a matching grant program does. Further, communities which already have undertaken substantial debt commitments to complete other investment projects may be reluctant to incur a substantial increase in debt -- even though their annual debt service costs might be identical between a partial grant program and a full loan program. An absolute increase in debt does decrease municipal capacity to fund other projects in the short term. Any of these situations may cause a particular community to avoid a loan subsidy program (whereas it would have participated in a grant program).

Loan programs, however, can be tailored to circumvent any debt ceiling, debt capacity, and public acceptance limitations. In many states, bond referenda are not required for revenue bonds. The debt of a public authority is not included in the community debt ceiling. The public authority/revenue bond financing approach places a program, at the local level, on a self financing basis. In this case, the community's future investment and expenditure patterns are not altered in an accounting sense.

The impact of a fixed interest loan program on the efficiency of the facility design stage of an abatement project is unlikely to be substantially different than occurs under the existing grant program if the subsidy levels are equal. Since, in considering the capital cost of a facility, a community is most likely to examine the annual cash flow and its effect on the tax rate, the community will not stress design efficiency with either alternative as long as the cash flow burden is equal. It can be argued that an equivalent loan subsidy will encourage more efficient design because it removes debt capacity available for other projects, and the community will seek to minimize project cost to retain maximum debt flexibility. However, this argument is too rigid because communities can almost always finance the capital portion of special purpose facilities outside their ceiling with revenue bonds. Thus technically efficient abatement must be achieved by finding solutions to the problems that are inherent in any capital subsidy program (a loan or a grant).

1/ Leverage, as used here, refers to the municipality's opportunity to invest one of its dollars in a program and gain the use of additional dollars supplied by the federal or state government at no further municipal cost. In this sense, matching grants and outright grants are financial options that leverage the municipal dollar.

A loan program in which the interest rate is dependent on facility performance would have different effects. First, if the interest rate were reduced to reward adequate facility performance, one of the most serious drawbacks of the current grants program -- underperformance of well-designed treatment plants -- could be overcome. The concept of a variable interest rate determined by system performance could improve the operation of water treatment plants. Second, by focusing the subsidy on performance of the plant there would an incentive for the municipality to think more carefully about its ability (financial, manpower skills, capacity needs) to operate the plant at the maximum subsidy level. Thus, this type of subsidy could encourage the design of more efficient plants as well as lead to improved performance.

Of course, as already mentioned above, if the loan program were structured with a fixed interest rate, no special incentives for adequate performance would be created, and the performance incentives of the loan subsidy would be identical to the existing grant impacts.

Summary

The preceding discussion has pointed out that a federal loan program could be structured to provide a realistic option to the existing grant program. This could be accomplished by adopting an interest rate low enough that the loan subsidy and grant subsidy are equivalent. Further, a loan program would guarantee eventual program self sufficiency. It could be designed to encourage both more efficient initial facility design and improved operation and maintenance in subsequent years. On the other hand, a loan program would not result in a reduced federal financial role unless the interest rate was at a level where the total interest subsidy would be less than the immediate subsidy provided by a grant. Thus, if a loan program was designed to reduce the federal financial role, it would also provide a reduced incentive for construction of wastewater treatment facilities.

The option of exchanging the current grant program for a reduced interest loan program is not an especially realistic option for consideration at this time. There has been no indication in the Congress of interest in such a drastic programmatic switch in order to achieve benefits that can be obtained in alternative ways. Moreover, the administrative difficulties that would be concomitant with a shift from grants to loans would be substantial enough that the ultimate objective, obtaining clean water, would likely be impaired. This administrative problem can be expanded on by noting three issues.

First, if a loan program were initiated, there would be a significant procedural uncertainty in the EPA regions, in the states and in the municipalities as the process shifted from grants to loans. The result of this uncertainty would be a lag in transition between the grant and a loan program. States and municipalities would await the new procedures and guidelines before proceeding with their plans. The EPA would have to adjust its staffing and organization to meet the new requirements. Second, until the current backlog of projects is depleted, it would be difficult to shift to a new financing program. Maintaining two programs to review and fund projects would be confusing and costly. Third, the legislation in PL 92-500 would have to be changed to permit a shift from grants to loans. This, of course, is more difficult and time consuming than other options to improve the current program already discussed in Chapter IV.

Though a loan program is an option to the existing grant program, the EPA, for the practical reasons suggested above, does not recommend its adoption at this time. Perhaps when the current backlog of major projects has been completed, a loan program would be more viable. At this time, a shift in the technique of financing the program would tend to delay pollution abatement and complicate the administration of the program.

APPENDIX A

LEGISLATIVE HISTORY OF FEDERAL WASTEWATER FINANCING PROGRAMS

This chapter summarizes the salient elements of recent Federal legislation relating primarily to the financing of municipal water pollution control projects. The period covered is 1948 to the present. For this Report, the most relevant differences in the Acts concern the allocation of authorized funds to the states and the distribution of these allocated Federal funds to municipalities based on a predetermined Federal share of pollution control costs.

Public Law 80-845: 1948

The current version of the Federal Water Pollution Control Act has its roots in Public Law 80-845, passed in 1948, which authorized loans and other assistance to states and municipalities trying to deal with water pollution. Public Law 80-845 declared it to be the policy of Congress

> ... to recognize, preserve, and protect the primary responsibilities and rights of the States in controlling water pollution, to support and aid technical research to devise and perfect methods of treatment of industrial wastes which are not susceptible to known effective methods of treatment, and to provide Federal technical services to State and interstate agencies and to industries, and financial aid to State and interstate agencies and to municipilities, in the formulation and execution of their stream pollution abatement pro- ... grams. (Section 1)

The Surgeon General under the Public Health Service, the Federal Works Administrator, and the Federal Security Administrator were to administer the program. Under Section 5, the Federal Works Administrator was authorized to make loans to states, municipalities, or interstate agencies to construct treatment works preventing the discharge of untreated or inadequately treated wastes. Loans could also cover the preparation of engineering reports, plans, and specifications. Loans were to be made only if a project was approved by the Surgeon General and by the appropriate state agency and was part of a "comprehensive" plan. Loans were limited to a Federal share of 33.3 percent of the "estimated reasonable cost' or $250,000, whichever was smaller, and carried an interest rate of two percent. Section 5 also provided that:

> ... bonds or other obligations evidencing any such loan (1) must be duly authorized and issued pursuant to State and local law, and (2) may, as to the security thereof and the payment of principal thereof and interest thereon, be subordinated (with agreement of Federal Works Administrator) to other bonds or obligations of the obligor issued to finance such project or ... that may then be outstanding.

Projects were to be ranked by considering the "public benefit to be derived," the "propriety of Federal aid in such construction," the relation of the full costs of construction and maintaining works to public interest and necessity, and the "adequacy of provisions ... for assuring proper and efficient operation and maintenance of the works" after construction.

Public Law 80-845 authorized $22.5 million for loans under Section 5 for each fiscal year from 1948 to 1953 (Section 7) and $1 million for those years for grants for the preliminary planning and engineering work on approved projects. Public Law 82-579 extended the life of 80-845 until June 1956. The funds, however, were never actually appropriated (1).

Public Law 80-845 was substantially amended in 1955-56, 1961, 1965-66, and 1972. Since 1948, the debate around and modifications to the water pollution control legislation related to the construction of waste treatment works have focused on several central issues: (1) the proper role and authority of states in managing their environmental affairs, particuiary waste treatment; (2) the size contribution or "share" the Federal government should provide to state pollution control projects (the grant formula); (3) the distribution formula used to determine how authorized Federal money should be allocated among states and among municipalities of different sizes (the allotment formula); and (4) the criteria or safeguards used to insure efficient use of Federal funds.

Over time several things have become clear. The extent and severity of pollution in this country is outstripping any provisions for its abatement and control. The formulae for the distribution of funds to states and among various localities generally contain biases and inherent inefficiencies. Delays in obtaining Fedeal financial assistance have led many states and municipalities to put off pollution control plans or, in some cases, to take the initiative in financing their own treatment works. In general, total authorizations have steadily increased in recognition of the dimensions of the pollution problem, although actual appropriations have consistently fallen short of authorized levels. The formulae for determining the Federal share and the distribution of money to states have been charged repeatedly in any effort to satisfy all relevant parties. Although Federal involvement has increased over the years, some states and municipalities have found it more expedient to prefinance their treatment facilities rather than wait for Federal money before they initiate construction.

Public Law 660: 1955-56

During the 1955-56 Congressional sessions, two bills (S. 890 and H. R. 9540) were introduced to replace Public Law 80-845, which was about to expire. In both bills, the Surgeon General, through the Public Health Service under the Department of Health, Education, and Welfare (HEW), was authorized to investigate pollution sources and causes, and to make grants for research, demonstration projects, and training personnel to operate and maintain treatment plants. s. 890 provided that the Surgeon General would

> ... from time to time make allotments to the several States, in accordance with regulations, on the basis of (1) the population, (2) the extent of the water pollution problem, and (3) the financial ... need of the respective State (2).

The Surgeon General also was given the broad power to allocate money to interstate agencies on "such basis as (he) finds reasonable and equitable (2)."

The importance of recognizing and preserving "the primary responsibilities of the States in preventing and controlling water pollution (2)" was emphasized, as was the proposed legislation to provide the support and aid in technical research, which was seen as the most effective stimulant to state control programs. HEW officials testified at Senate Public Works Committee Hearings in April, 1955, that "experience with other health programs has demonstrated the value of matching grants in stimulating States to provide their own resources to do an effective job." It was argued that Federal support was most effective in the form of planning, research, consulting, and technical assistance on tasks which most states could not adequately perform but which were critical to carrying out construction of treatment works.

In line with the argument that matching funds would stimulate state involvement in pollution control, S. 890, Section 5, spelled out a formula for the Federal share in control projects:

> The 'Federal share' for any State shall be 100 per centum less than percentage which bears the same ratio to 50 per centum as the per capita income of such State bears to the per capita income to the continental United States (except Alaska), except that (a) the Federal share shall in no case be more than 66 2/3 per centum or less than 33 1/3 per centum, and (b) the Federal share for Hawaii and Alaska shall be 50 per centum, and for Puerto Rico and the Virgin Islands shall be 66 2/3 per centum.
>
> The 'Federal share' shall be promulgated ... on the basis of the average of the per capita incomes of the States and of the continental United States for the three most recent consecutive years for which satisfactory data are available from the Department of Commerce.

In other words, each state received a share of money based on its average per capita income. The exact percent of project costs that the Federal government would bear was figured on the ratio of the state's average per capita income to the average per capita income of the nation. No state, however, was to receive a share more than 66.6 percent or less than 33.3 percent of the actual costs of the local project.

H.R. 9540, Section 6, provided direct Federal grants to assist municipalities in the construction of sewage disposal facilities, again emphasizing the "established principle of recognizing the primary rights and responsibilities of the States in controlling water pollution." Instead of the construction loans authorized (but never appropriated) in 1948, this bill provided for matching grants to states, municipalities, intermunicipal agencies, and interstate agencies, for the planning and construction of treatment works. Grants were to be limited to 33.3 percent of the estimated "reasonable" cost of construction or $300,000, whichever was smaller. In recognition of the fact that a few large cities needed amounts that would deplete at least 50 percent of the funds authorized for treatment works these amounts were to be directed to communities with a population of 250,000 or less, with priority given to municipalities that had done advanced planning. The then-current administration did not endorse Section 6, and took the position that the costs for treatement should be borne by the users of the service, not by the Federal government in the form of grants (3) (Another bill, S. 982, provided for grants of up to 50 percent of the cost of construction.)

The conference and final version of the bills provided two things: for the Surgeon General to make grants for construction of "necessary" treatment works and for a number of more specific criteria for the awarding of grants. As was the case in the original Federal Water Pollution Control Act, no grant was to be awarded unless the project was approved by the appropriate state water pollution control agency and the Surgeon General, and unless it was included in a "comprehensive" pollution program; no grant was to be for more than 30 percent of the estimated reasonable cost or up to $250,000, whichever was smaller, and the grantee had to agree to pay the remaining cost. Applicants had to demonstrate that there would be "proper and efficient operation and maintenance" of treatment works after completion, and treatment operation had to conform to state pollution control plans (Section 6(b)(3)). In making his decision about allocations, the Surgeon General was instructed to consider the public benefits to be derived from the project, the relation of ultimate costs to public necessity, and the adequacy or provisions for operation and maintenance (Section 6(c)).

Fifty percent of appropriated grant sums were to be alloted to states on the basis of the ratio that the population of each state bore to all the population in all states.

The other 50 percent of appropriated funds was to be allotted to each state based on a complicated ratio formula. Each state would receive an allotment determined by dividing the per capita income of the entire United States by the per capita income of each state, adding all 50 quotients so derived, and determining the ratio that each state's quotient was to the total of the quotients.

The Act authorized $50 million, wherein 50 percent of appropriations were to go to municipalities of 250,000 or less (Section 6(d)). "Construction" was defined to include preliminary planning, engineering and feasibility studies, and improvement or extension of treatment works (Section 6(e)).

The 1955-56 sessions also were presented with a dozen bills providing for the rapid amortization by industry (60 months) fo the cost of industrial treatment works, if the facilities were installed on the basis of demand from local governmental bodies and if the facility was part of an overall program for pollution control. Municipalities had complained that industrial wastes was one of the problems they could not handle through their ordinary residential treatment works. None of these bills, however, was incorporated into Public Law 660.

Federal Water Pollution Control Act Amendments: 1961

In 1961, the major changes made in the Federal water Pollution Control Act were to increase the annual amortization of funds and to raise the ceiling on maximum grants to a single project. The Amendments of 1961 increased the annual authorization for construction grants on a graduated scale from $50 million in fiscal year 1961 to $80 million in fiscal year 1962, $90 million in fiscal year 1963, and $100 million for fiscal years 1964-1967 (Section 5(d) in [4]). Again, 50 percent of the appropriated funds were earmarked for cities of 125,000 or under. Maximum grants were increased from 30 percent or $250,000, whichever was smaller, to 30 percent or $600,000, whichever was smaller (Section 5(a)).

Several other features were added to the Act. A project serving more than one municipality could be funded by applying the grant formula to each community's portion of the project as if it were a separate project. The sum of the maximum grants or $2.4 million, whichever was smaller, was to be made until all applications were funded that met the regulations in effect prior to the Amendments and that were filed with the appropriate state agency during the first twelve months after enactment of 1961 Amendments.

This Act further provided that all money alloted to states that remained unobligated for six months beyond the eighteen-month allotment period could be reallocated to states with an excess of approved projects (Section 5(c)). The administrative agent of the Federal Water Pollution Control Act, as amended, was changed from the Surgeon General to the Secretary of Health, Education, and Welfare.

1966 Amendments: The Clean Water Restoration Act

During the 1966 session of Congress, debate over the Federal Water Pollution Control Act Amendments centered on the formula for granting Federal money to local projects. The testimony at hearings on the large number of bills submitted to amend the Federal Water Pollution Control Act presented an enormous amount of data documenting the increasing demand and critical need for pollution control projects and the flaws and biases of the existing legislation (5). Witness described how the 30 percent limit on grants discriminated against both the largest communities and the smallest towns. A "needs survey" conducted and presented by the Conference of Sanitary Engineers showed that, if the ceiling for each grant were $1 milllion, 70 projects, totaling $49.6 million, in the then-current backlog of applications would qualify for grants over $600,000 but under $1 million. Forty other projects would qualify for over $1 million but under $2 million, for a total cost of $183.8 million (if the ceiling were $2 million). Eighteen proposed projects were so large that 30 percent of their cost would be $2 million, with a total cost of $255 million. On the other hand, many small towns could not even qualify for maximum grants on the basis of their population counts, nor did they have the capability to finance treatment works on their own (5, page 89).

The slowness in receiving Federal grants was repeatly mentioned as a deterrent, both because municipalities delayed construction in the hopes of eventually receiving Federal dollars, and because even approved projects could experience lag times of nearly years. A number of witnesses stressed the importance of allowing swifter reallocation of monies that were unused.

The size of the pollution problem prompted the introduction of a large number of bills aimed at easing the costs of municipal financing of treatment works. Again on the basis of the burden industrial wastes placed on municipal systems, 66 bills were filed to allow a tax deduction for construction costs of treatment facilities. Another dozen were filed to provide money to help retire municipal bonds. There was also interest in providing money to help train people for the efficient operation and maintenance of new facilities. Debate on several bills during hearings raised the idea of reimbursing states for pre-financing of treatment works.

The bills that eventually became Public Law 89-753 initially authorized increasing the authorization for construction grants from $150 million in 1967 up to $1.25 billion in 1971 (6). Again, at least 50 percent of the first $100 million appropriated was to go to municipalities of 250,000 or less.

The general allotment formula to states was the same: the first $100 million appropriated in a fiscal year was to go to states on the basis of population and per capita income weighted equally; sums appropriated above $100 million were to be allotted on a straight population basis, with a 10 percent incentive for regional planning of projects. State allotments were usable for the reimbursement of state or local money used prior to June, 1971, and after June, 1966, for projects built without Federal assistance (if approved) or with less than the Federal share allowable if sufficient funds were available.

The grant allocation formula was changed substantially in this law with a number of built-in incentives attached. The Federal government was committed to provide 30 percent of the cost of treatment works if the state provided 25 percent of the cost. The Federal share would be increased to 40 percent if the state picked up 30 percent of the cost. If the state had adopted enforceable water quality standards for the treatment projects affected, the Federal share would increase to 50 percent if the state only contributed 25 percent. Again the criteria established in the 1961 Amendments for selecting projects remained the same, with emphasis on the state determination of priority. River basin plans were eligible for a 50 percent Federal share. The ceiling on individual projects was eliminated, and there was a provision included for loans of up to $250 million.

The committee report on the proposed Amendments stressed once again the need for tax incentives to industry to treat their own wastes. The existing Act contained a provision for a seven percent investment credit for the acquisition of air or water pollution facilities, which was retained in the Amendments with the provision that facilities met Federal and state specifications. (S. 2857 proposed to increase the tax credit to 14 percent, but it was not acted upon. See (7)).

Water Quality Improvement Act: 1970

In 1970, a variety of bills were presented to increase the Fedeal share and the total and annual authorizations for pollution treatment programs. The Administration bill (S. 3472) estimated that $1 billion Federal input was sufficient to cover both the backlog and the increasing needs until 1974. This bill also proposed to reimburse states for prepayment from current appropriations, and a comparion bill suggested an Environmental Financing Authority to be managed through the Treasury Department to assist states and localities in borrowing funds they could not obtain through grants. The allocation of funds was to be made on the basis of a new formula which considered population and the severity of local pollution conditions. Sixty percent of the Federal funds was to be allocated by population and income; 20 percent was to go to those states which paid at least 25 percent of the cost of all assisted projects, distributed on a population basis; and 20 percent was to be allocated on the basis of the severity of the water pollution problems and the local ability to use funds for basin-wide plans. This last 20 percent was considered "discretionary money" to offset the needs of especially large projects; first priority would go to reimburse states that had pre-financed plans. (The 1966 Amendments had encouraged a number of states and localities to pass bond issues or arrange other means to finance the Federal share of costs in anticipation of reimbursement, and by 1969 over $300 million in backlog payments was due (8).)

Another bill, S. 3687, challenged the Administration estimate of needs and proposed to authorize $2.5 billion per year for six years. The formula in this bill was similar to the earlier 1955 bill, with the Federal share being 100 percent minus the complicated percent calculated from ratios of per capita income in individual states to the entire country. At the time, only 16 States were providing the matching shares to raise the Federal share above 30 percent.

The Amendments of 1970 as finally passed contained Title I -- the Water Quality Improvement Act -- which made few changes in the sections related to construction grants for waste treatment works. The Federal government's commitment to make grants or contracts related to training students "to enter an occupation which involves the design, operation, and maintenance of treatment works, and other facilities whose purpose is water quality control" was expanded by the stipulations in a newly-added section (Section 16).

The 1970 Amendments (Title III) also replaced the Federal Water Pollution Control Administration with the Federal Water Quality Administration. Authorizations remained at the level voted in 1966, or $1 billion for the fiscal year ending June, 1970, and $1.25 billionf or the fiscal year ending June 30, 1971.

Public Law 92-500: 1972

The next major overhaul of the Federal Water Pollution Control Act came in 1972. Title II, called "Grants for Construction of Treatment Works," expanded the purposes of the Act and specified goals related to new technology (including reclamation and recycling). Although Federal financial assistance is not limited to this revised Act or its predecessors (HUD, EPA, and FHA, for example, all have authority to grant funds for treatment plants), the new Act has taken precedence over most other funding sources. Authorizing legislation for other grant sources have not been considered in this discussion.

Several broad new conditions were placed by the 1972 Amendments on the allocation of grants after June 30, 1974, including that:

-- Projects provide for the application of best-practicable waste treatment technology over the life of the works:

-- Projects will consider and allow for the application of new technology for reclaiming or recycling water; and

-- Each sewer collection system discharging into the treatment works is not subject to excessive infiltration.

The Amendments as finally adopted and passed over the President's veto provided for 75 percent Federal grants for facility construction, with no specified state participation required. (The Senate bill provided for a 70 percent Federal Grant if the state participated with a 10 percent grant; the House bill provided for a 75 percent Federal grant if the state participated with a 15 percent grant or loan. No state participation would have lead to Federal grants of 60 percent under either bill.) The Amendments further provide for an Environmental Financing Authority to assure municipal access to funds to finance its share of project costs and for the allocation of funds among states according to need for treatment plant construction.

In the main text of this Report, a more extensive discussion of P. L. 92-500 was presented. This laid the foundation for analysis of those elements of the present financing program that appear in most need of careful scrutiny. However, because of the Act has been discussed in some detail above, that material has not been reiterated here.

References

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2. *Water Pollution Control Act Amendments of 1956*, Public Law 660, *84th Congress, Chapter 518, 2nd Session, S. 890*.
3. *Congressional Record*, June 13, 1956, Page 10240 ff.
4. *Federal Water Pollution Control Act Amendments of 1961*, Public *Law 87-88, 87th Congress, H.R. 6441, July 20, 1961.*
5. *Hearings*, U.S. Senate Committee on Public Works, May 19, 1964.
6. *Clean Water Restoration Act of 1966*, Public Law 87-753, 89th Congress, *S. 2947, Title II, Section 205, November* 3, 1966.
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8. *Senate Public Works Committee Hearings*, Subcommittee on Air and *Water Pollution, April 20, 1970, Page 2*50.

APPENDIX B
NONPOINT SOURCE CONSIDERATIONS

I. Introduction

Nonpoint source pollution (NPS), i.e., pollution that is extremely difficult to identify or attribute to any particular source, may become a major obstacle to attaining the 1983 water quality goals. However, the lack of sufficient technological, cost, water quality and economic knowledge has precluded the implementation of effective, efficient national programs for dealing with nonpoint pollution.

This appendix discusses the serious problems associated with any attempt to control NPS. Section II briefly discusses the general attributes of NPS which must be addressed by any control program. Section III describes the categories of nonpoint pollutants and broadly indicates the relation between these pollutant categories and the corresponding economic activities that generate the pollutants. Section IV describes, in very general terms, economic incentives and penalties which could be applied to control NPS. However, work in this latter area is not sufficiently developed to suggest appropriate financial policies for dealing with the problems discussed in the earlier sections.

II. The Problem: Developing Regulatory or Subsidy Programs for NPS Control

Data limitations, while severe, do not by themselves explain the slow progress made toward developing the means to control NPS. Serious conceptual problems are inherent in the nature of nonpoint pollution. Five problems appear to be particularly important in the design of financing (and technical) approaches to the control of NPS:

1. Nonpoint source pollution stems from such a wide variety of causes and large number of sources that thorough monitoring is not possible. This makes development of even a regulatory program very difficult.

2. It is often difficult, if not impossible, either to separate natural from man-induced nonpoint pollution or to trace changes in ambient quality back to their source. This makes liability very difficult to determine. Hence, even if the monitoring problems with NPS were manageable, questions of legal liability could interfere with a regulatory or subsidy program.

3. Many NPS pollutants appear as "slug" loads, usually during or shortly after rainstorms. Therefore, any abatement activity must, explicitly or implicitly, assume a target storm frequency, e.g., once in every two years. Although the selection of a target storm frequency has widely varying cost and ecological consequences, the choice of a particular such frequency is, in practice, quite arbitrary.

4. The interrelationships between individual polluters is far more complex than is usual in point sources. For example,

in cases where a substantial amount of pollution is contributed from "uphill" sources, it may not be adequate to control waterfront acreage. Nor would it be equitable to hold waterfront owners responsible for pollution largely not of their making. Pesticides and nutrients are examples of pollutants that often drift far from the site of initial application. In addition, since there is seldom one "big" nonpoint source that can be controlled to the exclusion of others, controls may have to be uniformly applied in a geographic area to have significant impact on ambient water quality.

5. Many nonpoint problems appear to be directly related to land management practices. For example, a farmer's choice of strip, straight row, or contour plowing affects the quantity of soil and fertilizer introduced into adjoining streams. The courts are just now coming to grips with the legal issues surrounding private property rights and society's interests in land management.

III. Description of Nonpoint Source Water Pollutants

Nonpoint sources of water pollution vary considerably in type, and stem from a broad range of human activities and natural causes. The activities may be divided into five broad categories: agricultural-rural, forestry, construction, mining and urban. In many areas, pollutants stemming from these activities constitute a problem equal to or exceeding that of point source pollution.

The four most common types of pollutants associated with nonpoint sources are:

1. Sediments and floatable materials -- particles of dirt or soil consisting of both organic and inorganic material;

2. Nutrients -- primarily various chemical forms of nitrogen and phosphrous;

3. Dissolved solids -- usually separated into two types of water pollution, depending on chemical characteristics: (a) dissolved salts of sodium, potassium, calcium and magnesium sulfates, chlorides, carbonates and biocarbonates; (b) acid mine drainage; and

4. Toxicants -- particularly pesticides. In addition, nonpoint sources introduce heavy metals and organic chemicals into waterways that are toxic to man and animals. For these latter toxicants, little is known about the magnitude of the problem at this time. Hence this discussion will be basically oriented toward the effects and control of pesticides.

Except for toxicants, the pollutants described above occur naturally to some degree in almost every stream and lake. Within limits, they are necessary to maintain a healthy, balanced aquasystem; in excess they cause environmental degradation. Under certain circumstances, the pollutants can also cause or be responsible for a number of adverse economic impacts.

Adverse effects of sediments include covering bottoms of streams and lakes, which interferes with the natural stream ecology. Suspended sediments are also responsible for water occlusion (turbidity), which reduces light transmission and thus photosynthesis activity. The organic portion of sediments can increase biological oxygen demand (BOD) to a point where insufficient dissolved oxygen is available for certain fish and other aquatic life. Sediments also fill in reservoir, river channels and harbors, which either decrease their economic life and usefulness or increase the need for expensive dredging operations.

Excess nutrients are primarily responsible for excessive plant and algal growth in streams and lakes and result in eutrophication. When plants complete their life cycle and die they create heavy BOD loads, reducing dissolved oxygen levels necessary for aquatic life. In addition, the plant residues fill in lakes creating problems similar to those of excess sediments. Excessive algal growth can also cause an undesirable taste and odor to drinking water supplies, necessitating greater water treatment costs. Above certain levels, nitrates in drinking water are detrimental to health and can cause methemoglobinemia.

A high level of acid mine drainage can eliminate biologic activity in streams and rivers. It can also increase water supply treatment costs and be responsible for greater maintainence costs of structures that come in contract with the acid water.

The impact of dissolved salts at the levels typically encountered in streams is mainly economic. High concentrations of sodium ions and chlorides in irrigation water reduce production, restrict the variety of crops grown, and necessitate capital investments to deal with increasing concentrations of salts in soils. Carbonates and sulfates are responsible for "hardness" in water, which necessitates either additional water treatment for industrial and household use or increased maintenance and replacement of water-using equipment.

Pesticides have deleterious physiological effects, including potential carcinogenic or cancer-causing effects in man. Because of man's low tolerance, it is necessary to reduce unnecessary human exposure. Pesticides also often eliminate not only undesirable plants, insects and animals, but also desirable species that are present in the pesticide treated area, i.e., the pesticides are not specific to one species. Furthermore, due to the long length of time it takes for some pesticides to degrade into harmless elements, they are often concentrated at high levels in some animals that are at or near the end of a "food chain." High pesticide concentrations can, of course, have serious physiological effects on these animals and their offspring.

Whether through natural or by man-related activities, NPS pollutants are produced and introduced into waterways by rather simple and basic physical processes. Potential problems from excess sediments result whenever soil is disturbed and there is a means to transport the soil into streams. Rainfall and the resulting runoff on unprotected soil are examples of both a disturbing and a transport mechanism. Controls focus on measures to reduce the soil disturbance effect of the rain and/or reduce the velocity and consequent sediment-carrying capacity of the runoff.

A precondition for nutrient pollution is that there are more nutrients available than can be utilized by plants. Rainwater usually provides the vehicle for transporting nutrients into waterways. Controls are either directed at balancing the amount of nutrients on and in the soil to an environmentally desirable level and/or reducing excessive runoff. Since nutrients, expecially phosphorous, are associated with sediments, sediment controls are also useful in NPS nutrient reduction activities.

Increases in levels of dissolved solids are primarily caused by two actions: the concentration of the solids in water remaining after evaporation or transporation occurs, and from the addition of new dissolved solids leached from soils.

Any introduction of pesticides into the environment entails a high probability that a portion of it will eventually enter the water. The usual strategies for pesticide controls are concerned with insuring the safest applications occur, restrictions on use, or limiting the sale and manufacture of pesticides.

Table 1 indicates which economic activities are generally associated with the various nonpoint pollutants.

Table 1: Economic Activities and Nonpoint Pollutants

Pollutant \ Economic Activity	Agriculture	Forestry	Mining	Construction
Sediments	X	X	X	X
Nutrients	X	X		
Dissolved Solids	X		X	
Pesticides	X	X		

IV. Economic Incentives/Penalties

As discussed previously, due to the characteristics of nonpoint sources, there have been virtually no efforts directed toward development of effective, efficient economic incentive and control mechanisms for NPS pollutants. This section discusses, in very general terms, the kinds of economic incentives and penalties that might be subjects for future analysis for NPS pollution control. The section is organized according to the economic activities that generate most NPS pollution: Agriculture, forestry, mining, and construction.

Agriculture

The nonpoint pollutants associated with agricultural activities are the following: sediments, nutrients, dissolved solids (salts), and pesticides.

Sediments --

Actions to reduce sediment loadings involve either (1) changing land management practices, (2) capital investments, or (3) reduction of land use intensity.

Changing land management practices probably offer the greatest immediate opportunity for sediment reduction. These include (1) conservation tillage, (2) substituting strip cropping and contour plowing for straight row plowing, and (3) more extensive crop rotation. Although adoption of these practices may in fact increase farm earnings, they have not been widely adopted because many farmers are unaware of their benefits and lack the expertise to effectively implement them. In such cases, Federal provision of technical aid might both increase farm income and reduce sediment loadings. In those areas where agricultural sediment loadings impair water quality goals, technical aid might have to be combined with regulations and fines to achieve desired levels of abatement.

Capital investments are necessary to build the structures to reduce water runoff velocities and, thus, reduce erosion. Projects include terraces, diversions, and grassed waterways. Because of the costs involved, partial subsidies or long term loans appear to be the most effective means of encouraging these projects. Regulations and fines could, where such capital investments were not economic, result in some farm closures.

Reduction in land use intensity generally involves converting crop or tilled land either to active pasture, idle pasture or woodland. Such practices are especially necessary in cases where the land can support crops or intensive grazing for only a few years before severe deterioration results. A land bank program might provide the necessary incentive to reduce land use intensity. However, such an approach requires payments over time and is generally only effective when the incentive payment is equal to or greater than profits foregone on retired land. Outright purchase or environmental easements would probably be too expensive and administatively cumbersome. Consequently, the enforcement-fine approach seems likely to be the most effective means of reducing pollution from excessive land use.

Nutrients --

Improper and excess applications of manufactured fertilizer developed as the relative price of fertilizer in relation to other inputs declined. Consequently, a unit charge or tax to increase the price of fertilizer relative to other inputs should encourage a move back to conservative use of fertilizers. It should be noted, however, that recent price increases and fertilizer shortages may have effectively provided as much control as could be expected from a legislated tax. Given the interrelationships between sediment and fertilizer controls, it may be necessary to rely on the former if further nutrient reductions are necessary.

Nutrients from animal wastes, especially small feedlots, have been treated as nonpoint sources. In actuality, a number of states classify most animal feeding operations as point sources and control them as such. Given the proven practicability of classifying animal feeding operations and their resultant nutrient pollutants as point sources, these sources could be required to conform to the regulations promulgated for larger operations in this type of economic activity.

Dissolved Solids --

Irrigation water is a scarce natural resource in most places. In arid regions, various institutional constraints have precluded the use of the price system as a means of allocating water. Consequently, water is often used inefficiently and its salinity is increased above justifiable economic levels. Cost sharing subsidies could be used in some instances for structures (e.g., lined irrigation ditches and canals) to reduce salinity. Though a subsidy would probably lead to more efficient water use, because of the "water rights" legal structure in most arid regions, salinity would not necessarily be reduced. A unit charge or tax on water use might both reduce inefficient use of a scare resource and also reduce salinity.

Pesticides --

Pesticide registration and certification of applicators have been implemented through the Federal Insecticide, Fungicide and Rodenticide Act (P. L. 92-516). If this law needs to be supplemented, a combination of subsidies, tax and information programs might be effective. For example, subsidization of pest management programs would reduce private insecticide use and costs; a unit charge would reduce general pesticide use; and mandatory participation in pesticide training programs, with the program financed by pesticide taxes, could reduce excessive use of pesticides.

Forestry

Unlike agriculture, most sediment from forestry is due to road construction and maintenance practices. Under most logging situations, there are known methods, techniques and practices available to reduce water pollution from this source. On lands under the jurisdiction of the U.S. Forest Service, activity permits governing the construction and upkeep of logging roads appear to be sufficent to significantly reduce sediment loadings. However, these regulations are not rigorously enforced, due to personnel, financial and other constraints.

Sediments resulting from the removal of trees can often be controlled by leaving "buffer strips" or undisturbed zones of trees along streams. These buffer strips control sediment by reducing runoff velocities and trapping sediments before they can enter the streams.

Subsidies for environmentally-sound road construction would not necessarily achieve pollution control objectives because of the operational characteristics of the logging industry. Performance bonds and fines would have a higher probability of success. Such penalties would also tend to increase economic efficiency by incorporating environmental control costs into the price of lumber.

Subsidies to encourage buffer strips on private lands would have to be equal to or greater than the net value of the timber which otherwise would have been harvested in order to be effective. There is a possibility that property tax relief would achieve this objective, but in most cases, purchase of a property right, such as through scenic easements, would probably provide the most effective control. However, because of the administrative expense of easements and subsidies, the use of penalties may be cheaper and as effective.

Mining

Nonpoint source pollution from mining activities primarily relates to inactive or abandoned mines -- most pollutants from active mines are covered under point source regulations. In both quantity and quality the worst water pollution from past mining activities originates in the Appalachian Region of the U.S.

Because of the difficulty in determining ownership and because of the physical and economic magnitude of the reclamation problem, penalties probably would not be effective in an implementation strategy. For the latter reason, subsidies to mineral right owners might not be effective either. State and regional commissions have had some success in reducing pollution from inactive mines. However, progress has been slow partially because of a lack of sufficient funds. Federal loans or subsidies to states and regional commissions might increase the rate of progress.

Construction

The Federal government classifies construction as a nonpoint source. Most construction activities, however, require building permits or other types of local, state or Federal government approval which essentially delegates them to a point source problem. Controlling sediment from many construction activities is not technically difficult nor expensive relative to total construction costs. Furthermore, monitoring of sediment controls could be undertaken in conjunction with other required inspections. It, therefore, appears that increased regulation and fines would provide an effective, administratively feasible means of reducing construction pollutants.

V. Summary

Water pollution from nonpoint sources is unique in its relationship to other types of water pollution sources. Pollutant loadings vary widely over space and time, are dependent on natural phenomena, are difficult to monitor, are often not directly traceable to human activity and are sometimes not susceptable to control by existing technology. Furthermore, many of the programs through which the technical and economic incentives or penalties to control NPS would have to operate are not under the jurisdication of the EPA. Hence, jurisdictional problems may arise. Until these sorts of problems are resolved, and NPS pollution gets greater attention (including, in many instances, basin planning), this area will continue to be an impediment to achieving national water quality goals.

APPENDIX C
OPTIMAL DESIGN PERIODS FOR MUNICIPAL WASTEWATER CONSTRUCTION PROJECTS: A MATHEMATICAL DERIVATION

A major economic problem in the planning of wastewater construction projects is the determination of an efficient level of reserve capacity. Reserve capacity is the treatment capability in excess of that needed to service the existing population. Reserve capacity is required to satisfy future requirements. Since resources used to provide future service cannot be used (except perhaps to improve reliability) to satisfy current abatement needs, the level of reserve capacity must be appropriately established in order to obtain efficient facility design.

The level of initial reserve capacity, in conjunction with the expected growth in demand for wastewater treatment services, defines a project design period, which is the expected time interval between expansions of a pollution abatement project. This Appendix is a "first cut" attempt to address, in mathematical terms, the determination of the optimal design period for a broad class of treatment plant and interceptor sewer construction projects.

The findings indicate that wastewater project plans should generally call for design periods which are shorter than 20 years for treatment plants and 50 years for interceptors. When the planned level of reserve capacity and hence the design size of federally supported wastewater construction projects are too large, not only is the allocation of pollution abatement resources economically inefficient, but the Federal cost-share, especially short-run project funding, is also too large. This is a source of concern to EPA and is currently the subject of further analysis in EPA's Office of Water Programs. A model more sophisticated than that indicated below is under development to determine optimal design periods. This model is presented only to illustrate the use of analytical tools in the design of treatment plants and interceptors.

The Model

Suppose that within a community, existing wastewater capacity is just sufficient to satisfy the existing population, plus population growth during the time interval necessary to provide expanded capacity. It is also assumed that capacity growth will keep pace with demand. Given the cost of expansion, (expressed as a function of expansion size), the interest rate, and the annual growth in demand for treatment services, the objective is to determine the optimal design period for treatment works expansion. Equivalently, the problem is to determine the optimal time interval between treatment plant expansions.

The following assumptions are made:

1. Demand is deterministic and a linear function of time.
2. The cost of capacity expansion is known and deterministic.
3. The equipment has an infinite economic life.

Figure 1 charts the course of demand and of capacity over time under these assumptions.1/

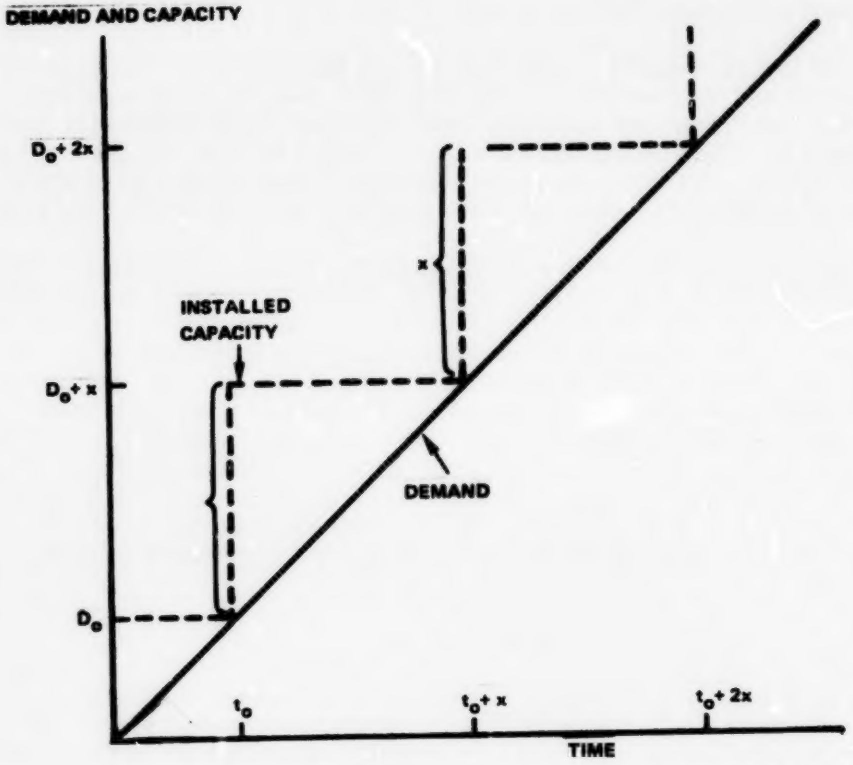

FIGURE 1. – GROWTH OF DEMAND AND OF CAPACITY OVER TIME.

In figure 1, t_o denotes the date of the initial expansion in capacity, and D_o indicates the demand, in capacity units, at time t_o. Note that x, in the expressions $(t_o + x)$ and $(D_o + x)$, refers to both time and capacity units. This is because the physical unit of capacity is set equal to one year's growth in demand.

1/ The remainder of this model presentation is taken from Alan S. Manne's October 1961 *Econometrica* article, "Capacity Expansion and Probabilistic Growth," pages 633-636.

Excess capacity, when plotted on Figure 2, then displays a sawtooth pattern.

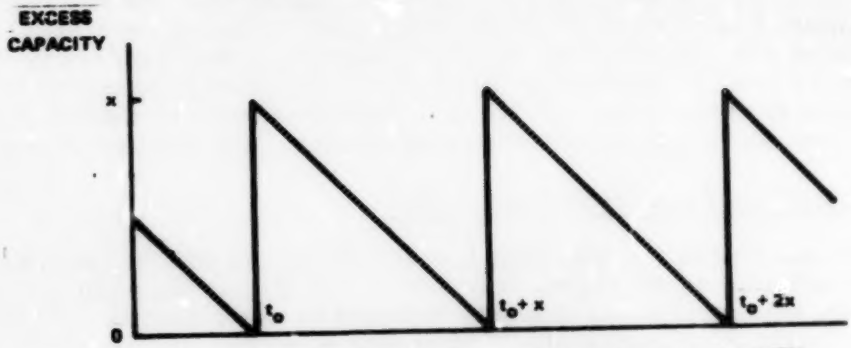

FIGURE 2. – EVOLUTION OF EXCESS CAPACITY OVER TIME.

The real installation costs that result from a single capacity increment [1] of size x are assumed to be given by a cost-relationship in the form of a power function:

$$kx^a \qquad (k > 0;\ 0 < a < 1)$$

If, for example, a, the economy of scale factor, equals 1/2, this cost function says that a facility capable of handling 16 years' worth of growth in demand is only twice as expensive as one that can accomodate four years' worth. The existence of such substantial economies of scale implies the desirability of building new capacity considerably in advance of demand. [2] But how much in advance? Here the discounting of future costs becomes crucial.

Without discounting, it would be perfectly sensible to spend a dollar now in order to save a dollar's worth of costs either next year or ten years from now, or even 100 years hence. There is no limit to the size of the facility that it pays to build. With discounting, on the other hand, this paradox can be sidestepped. [3] Throughout, the expression e^{-rt} refers to the present value of a dollar due t years in the future ($r > 0$). The quantity r represents the "discount rate."

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[1] In wastewater treatment works, capacity refers to effective, not physically possible capacity. Unused physical capacity is sometimes necessary to ensure that system reliability criteria are met. This analysis assumes that the same reliability standards apply to all facilities and that any differential costs between large and small facilities of achieving reliable operation is fully reflected in the cost function.

[2] A second reason for wanting to build new capacity in advance of demand is that the cost of constuction for that capacity may be expected to increase faster in the future than all other prices. For example, it may be substantially more expensive to install a new sewer after adjacent roads have been paved than it is to install the same sewer prior to any development.

[3] An additional reason for the discounting of future costs would the expection of continuing progress in treatment technology. It is possible that in (say) 10 years' time, the cost of building a facility with a capacity of x units will be significantly cheaper in real terms than the cost of such a facility today.

It should also be noted that the model assumes that the environmental implications of facility siting decisions and of pollution generation during construction are the same for any size facility. More explicitly, the model assumes (1) facility location is insensitive to facility capacity over very large capacity ranges, and (2) the cost functions already (implicitly) include expenditures sufficient to prevent environmental degradation during construction.

Derivation of the Optimal Design Period

As a time origin for subsequent calculations, it will be convenient to take any such point as t_o or (t_o+x) or (t_o+2x) on Figure 2, a time at which the previously existing excess capacity has just been exhausted. Such a point is called a "point of regeneration." Note that when one has reached $t_o + x$, the future looks identical to the way it appeared x units of time previously. Then, utilizing C(x) as a function of x that represents the sum of all discounted future costs looking forward from a point of regeneration, the following recursive equation may be written:

$$C(x) = kx^a + e^{-rx}\, C(x)$$

The first term on the right hand side indicates the installation costs incurred directly at the beginning of the current cycle. The second term measures the sum of all installation costs incurred in subsequent cycles, and discounts these from the next point of regeneration back to the present one, a difference of x years. It follows that:

$$\frac{C(x)}{k} = \frac{x^a}{1-e^{-rx}}$$

Differentiating ln C(x) with respect to x, and setting the result equal to zero:

$$\frac{d\ln C(x)}{dx} = \frac{a}{x} - \frac{re^{-rx}}{1-e^{-rx}} = 0, \text{ or } a = \frac{r\hat{x}}{e^{r\hat{x}}-1}$$

where $\hat{x}$ denotes the optimal capacity staging interval, [1] i.e., the optimal design period.

Illustrative Solutions

The reader can verify for himself that this last equation is not only a necessary condition, but also a sufficient one to ensure a unique minimum-cost solution. With this equation, the optimal capacity increment x, or, alternatively, the optimal design period, may be determined for any combination of the discount rate, r, and the economy of scale factor, a. Figure 3 exhibits illustrative solutions. The units are the same as in Figures 1 and 2 above, i.e., the optimal size is expressed in terms of years of excess capacity.

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[1] This result assumes that the real cost of facility construction is constant over time. If, for example, as a result of increasing population density, real cost increases at a continuously compounded rate s, then the result would be

$$a = \frac{(r-s)\hat{x}}{e^{(r-s)\hat{x}}-1}$$

The effect of increasing cost can, therefore, be captured by adjusting the discount rate downward by the rate of cost increase.

Optimal Design Period

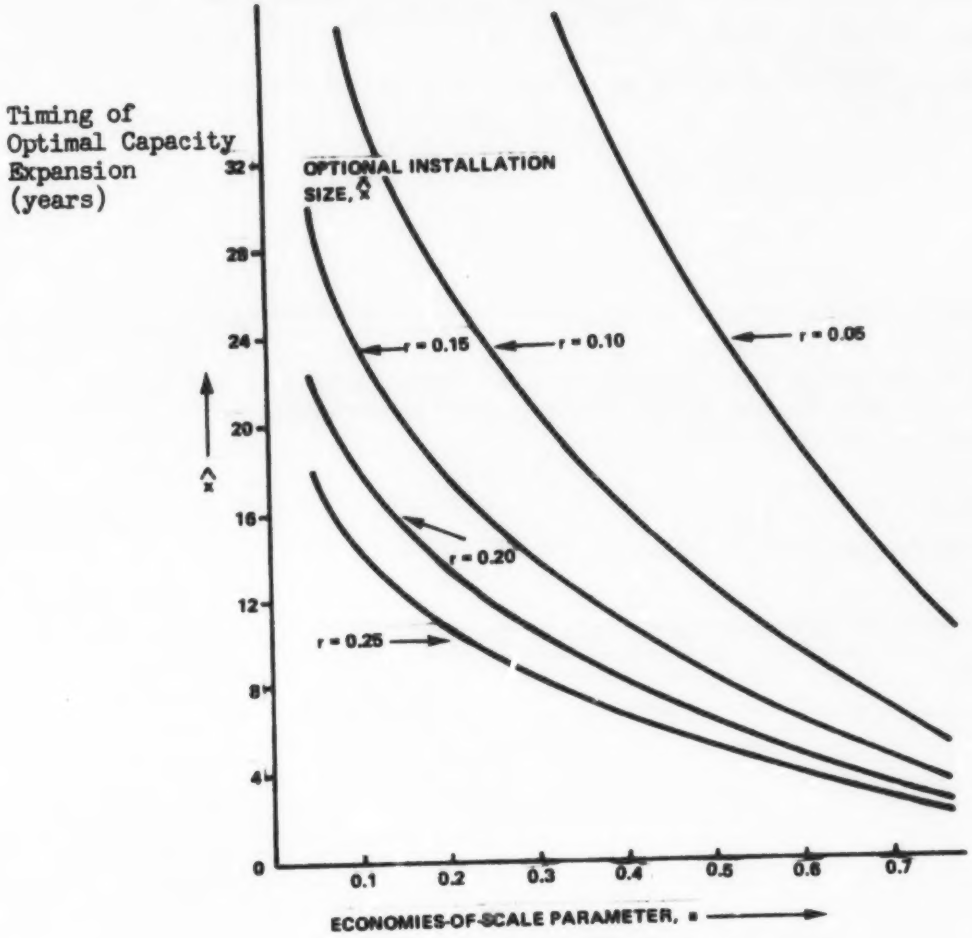

FIGURE 3.

Application to Wastewater Works

The economy of scale factor, a, typically varies between .6 and .8 for waste treatment plants. Table 1 shows approximations for the appropriate design period for various combinations of the economy of scale factor and the discount rate. For example, if the discount rate is 7%, and the economy of scale factor is .7, under the specified assumptions, the resulting design period is 10 years.[1]

Table 1

Optimal Design Period (Years): Treatment Plants

	Economy of Scale Factor		
Discount Rate	0.6	0.7	0.8
5%	19	13	9
7%	13	10	6
10%	9	7	4

For interceptor projects, the economy of scale factor typically varies between .3 and .5. Table 2 conveys the same type of information as Table 1 and is read in the same way.

Table 2

Optimal Design Period (Years): Interceptors

	Economy of Scale Factor		
Discount Rate	0.3	0.4	0.5
5%	40	31	24
7%	28	22	17
10%	20	16	12

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[1] Because of the model assumptions mentioned at the top of page C-4, the particular numbers shown in the tables should only be taken as illustrative of the general advisability of moving in the direction of shorter design periods.

Sensitivity Analysis

The results of any model are only valid when its assumptions are satisfied. Though relaxation of many of the capacity model's stringent assumptions result in shorter design periods, this is less true with respect to the assumption regarding fixed costs. Moreover, because there is no size differentiation, there are cases for which the model is not accurate.1/

1. Linear growth: Alternative assumptions are that growth is either exponential or asymptotic in nature. In the latter case, a corresponding linear function can generally be found which represents a good approximation to the asymptotic curve. In the exponential case, it can be shown that optimal design periods are shorter than in the linear growth case. Accordingly, the arguments in the last section would be strengthened by substituting exponential for linear growth.

2. Deterministic growth: One can also consider stochastic growth in the form of a uniform probability distribution. The results indicate that, in these cases, the optimal design period would be somewhat shorter than in the case of deterministic growth. In fact, the greater the variance of the uniform probability function, i. e., the higher the level of uncertainty, the shorter is the optimal design period. Once again, relaxation of the model assumptions strengthens the previous fundings.

3. Interest rates: Determination of the appropriate discount rate has traditionally proved elusive. Since the analysis assumes constant prices, it is reasonable to use a rate which is lower than the nominal rate observed in the market, inasmuch as the latter includes an expected inflation factor. In any event, higher interest rates imply shorter design periods.

4. Penalty costs: One of the model requirements is that demand is not allowed to exceed design capacity. This assumption implies that the cost of not providing sufficient capacity, in terms of treatment requirements, storage costs, and legal sanctions, is prohibitive. This is consistent with the 1972 Act.

5. Fixed costs: The costs incurred in planning and designing waste treatment facilities may not be directly dependent on the design size. However, these costs vary as a function of the number of expansions per unit time. Since significant fixed costs would tend to increase the optimal design period, this point merits attention. Rose 2/ conducted a break-even analysis for both treatment plants and interceptors. In the former case, it was found that over

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1/ Recent study has suggested the possibility that alpha, the economy of scale factor, changes with stage capacity. Particularly for interceptors, use of a Gompertz curve (or approximating the Gompertz curve with a series of exponential functions, one for each factor of ten increase in capacity) may provide a better fit to actual cost data. If so, the optimal design period may be differentiated by size capacity. The results, though not expected to change the general conclusion offered here, should be more realistic in suggesting the optimal design periods.

2/ Rose and Goldstein, op. cit., Chap. VII.

the relevant range of the scale factor, fixed costs per expansion would have to exceed 10% of 10-year capacity expansion costs before a 20-year design period becomes preferable to a 10-year period. For interceptors, over the relevant scale factors, preference for a 50-year design period would not occur unless fixed costs per expansion substantially exceeded (100% of) 25-year capacity expansion costs. On this basis, the 10/20 policy may be viewed as a lower bound to the optimal design period.

Implication

The above analysis suggests that the design period for the majority of federally supported waste treatment plants should be less than 20 years and for federally supported interceptors less than 50 years.

APPENDIX D

FULL TRUST FUND REPORT

(Due to its bulk, Appendix D essentially comprises a second volume to this Report to Congress)